Traffic Quarterly

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Police Training

Principal problems from increased traffic confront the public through parking, congestion, and voluble references to fatalities, injuries, and accident losses. Progress has been made in engineering and equipment. The combination constitutes our greatest advance.

Despite these improvements, difficult problems remain, chiefly in driver-qualification and attitude, and in suitable measures of driver-control. We need fuller, more nearly *unified* police training – by states for town and city.

Signs and other aids can *guide* drivers, but they afford little restraint for indifference or incompetence without effective enforcement – psychologically as well as technically effective. We need unified, thorough, and adequate training of traffic officers – unified so that throughout a state, at least, officers' arm signals and enforcement methods present to the public easily recognizable patterns and meanings, and the impression of helpfulness and justice, yet of authority and firmness.

In this area, progress has not kept pace – for every traffic officer. Some officers, of course, are all that could be desired. It is the imperfectly trained officer, using varied methods and attitudes, who confuses the public.

Not every police officer, solely because of his uniform and badge of authority, can properly direct traffic. The traffic assignment is as specific and important as any other. In one respect, the traffic post requires special judgment and firm tact because ninety motorists out of a hundred are law-abiding citizens who should not be needlessly endangered by indifferent, incompetent drivers. Yet they need direction and friendly control; at times, strict restraint. That requires sound training for both driver and police.

Good examples of requirements and appropriate training exist in the Federal Bureau of Investigation and the State Police. Members of these organizations command the respect of the public. They are trained and inspired in the proper performance of their duties.

Unfortunately, few town and traffic police are similarly well trained. Notable exceptions have the benefit of proper instruction

and careful selection. They perform excellently and they earn prestige.

Our driving record indicates that the subject of proper police training should be of national and immediate concern. It warrants the attention of state governments. Proper training goes far beyond traffic.

No municipality, however small, should be without trained police protection of a quality to justify the approbation and support of its citizens.

This high type of police schooling should win the sanction and commendation of all the country. It should contribute to a more law-abiding citizenry, not by pressure, but by respect and uniform understanding.

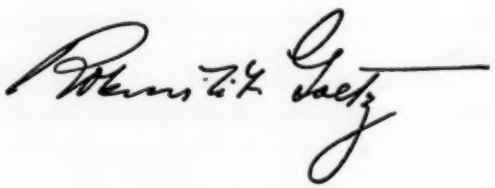
Some police are unaware of certain fundamentals primarily because they lack thorough instruction. This shortcoming – often through inadequately recorded evidence – is frequently the basic reason for the failure of a court to convict an offender. With a promising officer this quickly leads to discouragement and penetrates the efficiency and esprit of an entire force.

Mounting traffic with its accompanying confusion, with its unskilled and unruly drivers, definitely requires intelligent supervision and control by efficiently trained officers. To ignore this fact invites greater driving hazards and serious consequences.

To fulfill this long-recognized need of a well-trained, efficient police force seems, at first, an impressive task, but it is simplified when responsibility remains within each state.

States should prevail upon their legislatures to enact necessary measures to establish and maintain state-controlled schools for the training of the state's local police. Such legislation should receive the warm support of both citizens and enforcement officers.

To assure efficient enforcement, including traffic, would be a worthy sequel to the important duty of enacting laws.



Urban Highway Planning: Its Increasing Importance

C. D. CURTISS

Mr. Curtiss became Commissioner of Public Roads in January, 1955. In this position he directs the work of the Bureau of Public Roads of the Department of Commerce. With a B.S. degree in Engineering and a C.E. degree, he served overseas during World War I in the United States Army as a Captain of Engineers. In 1919, Mr. Curtiss joined the Bureau of Public Roads and was Assistant to the Chief of Bureau for eight years. Subsequently, he was in charge of finance and management activities of the Bureau. In 1943 he was made Deputy Commissioner. As Commissioner of Public Roads, he directs the large program of Federal aid to the states for highway improvement; of physical and economic research in connection with Federal aid; construction of roads in national parks, national forests and other Federal areas; and assistance on highway matters in the Philippine Islands, Turkey, Ethiopia, Liberia, countries of the Pan American Union, and in other foreign countries. Mr. Curtiss was the first Secretary of the Highway Division of the A.S.C.E. and carried on that work for twenty-five years. He was President of the Washington, D. C. section in 1948. Mr. Curtiss is a member of the American Association of State Highway Officials, of the Highway Research Board, and of the National Academy of Sciences. Mr. Curtiss was awarded a diploma by the A.S.C.E. for his distinguished service as Secretary of the Highway Division from 1923 to 1947. In 1951 he received the Exceptional Service Gold Medal Award of the Department of Commerce for a major contribution to administration of a Department program.

BY any previous standard the Federal-Aid Highway Act of 1956 sets the most imposing tasks ever encountered in the field of highway transportation. Physically the job is by far the greatest peacetime construction program ever undertaken. Within the next thirteen to sixteen years we must complete a 41,000-mile system of integrated modern highways linking the nation's principal cities and industrial centers, north and south, from Maine to California.

According to the terms of the 1956 Act we also must look ahead nearly twenty years – to 1975 – and locate, plan and design the kind of highways that will be needed to handle future traffic volumes. From present indications at least one hundred million cars, trucks, and buses will be in use, compared to the present figure of

sixty-five million. Undoubtedly this presents the greatest challenge in the history of American highway engineering.

These projects would be impossible of achievement in the allotted time without the twenty-two-year background of continued highway planning surveys and traffic research carried on by state highway departments in co-operation with the Bureau of Public Roads.

Thus the present program of assessing future highway and traffic requirements on the 41,000-mile national system of interstate and defense highways, and other federal-aid systems, is essentially a continuation of research and studies that have been going on for the last two decades. Now that the pace must be greatly accelerated, new methods and techniques are in order.

Nevertheless, the continuing need is for basic factual information, analysis and research that will enable us to remedy present highway deficiencies and also meet the far greater traffic demands that lie ahead.

Prior to World War II, the chief aim was to provide data dealing with our rural highway needs. That is still an essential objective if we are to handle the nation's unprecedented automotive travel on more than 3,000,000 miles of highways connecting towns, cities and regions.

But something new has been added to the historical pattern of highway development needs. This is the growing awareness of our urban highway programs. World War II greatly accelerated an existing trend of population movement from rural land to cities and metropolitan areas, and the rapid increase in automobile ownership has caused these areas to spread widely. These trends have continued since the war and there is no present indication that they will cease.

These changes have brought greatly magnified problems of urban highway and traffic engineering – where people are, traffic is. The Bureau of the Census estimates that in 1955 about 64 percent of the nation's total population lived in urban areas. The Stanford Research Institute estimates that by 1975 about 83 percent of our entire population will be urbanites in the full sense of the word or will be living in the suburban fringes of the major metropolitan areas.

With about ten percent of our total road and street mileage located in urban areas, and nearly two-thirds of our present population concentrated in these same areas, small wonder that traffic congestion is so apparent there. Equally obvious is the urgent need for action to relieve future congestion, when five out of six will be urbanites.

Planning for Future Adequate Roads

The 1956 Act recognizes the magnitude of this problem, and more than half of the federal funds for the interstate system over the next thirteen to sixteen years will be spent in urban areas. In view of the relatively small mileages involved, the per-mile costs of urban extensions will far exceed those in rural areas. And it is logical to assume that the thought and planning behind each mile of urban expressways and arterials will be proportionately significant. Selection of locations, traffic forecasts, and ultimate design call for the maximum in human foresight and careful planning.

We cannot, however, limit our efforts solely to expressway locations and design. We also must consider the interchanges with arterial highways and streets – and we need adequate data to gauge the ability of these routes to provide the traffic service required. In other words, expressways, arterials, and city streets together form the skeletal framework that shapes the economy and character of our cities. They are not separable in their functioning or in their planning. Only an integrated transportation plan can tie together our complex central cities and huge metropolitan areas with their diverse interests and activities.

How, then, are these problems to be resolved? What knowledge do we have, and what methods do we use? It is not possible here to examine these matters in detail. That has been done most effectively in a well-documented book.[1]

Since World War II we have made remarkable progress in the development of improved techniques for measuring and analyzing metropolitan area travel habits and traffic patterns. Prior to World War II, our knowledge of urban travel was almost entirely limited to traffic flow maps and tables. Our present task would seem insurmountable if continuing highway research had not combined

1. *Highway Traffic Estimation*, The Eno Foundation, Saugatuck, Connecticut, 1956.

imagination and engineering to develop new techniques in anticipation of future needs.

Let us face the situation squarely. Too frequently in the past our traffic estimates and forecasts fell far short of the mark. This deficiency, generally, can be attributed to our failures to recognize first, the impact of this country's increasing reliance upon automobile travel, and second, the impact of resulting highway development on the economy and growth patterns of our society.

Research is being carried out, and more is needed, to determine the relation between traffic growth and various other factors. It has been determined, for example, that since 1936, the growth of traffic has closely paralleled that of the Gross National Product – except during the war years. (Figure 1.)

Forecasts based on such relations are useful for general purposes. It is of particular importance, however, that means be developed through research, now being conducted, for making more accurate forecasts of traffic growth in specific situations.

Recent Achievements and Future Needs

Basically, two major achievements have been recorded in the field of highway planning research since 1945: (1) the development and subsequent refinements of the comprehensive metropolitan area transportation studies, and (2) the development of methods for determining highway capacity.

The first defines and charts the several traffic drainage basins in a metropolitan area, through an inventory of its resident population and analysis of their daily travel from origins to destinations by each mode of travel, and for a variety of purposes. As its name implies, it is a comprehensive study of the population of contiguous urbanized sections of our metropolitan areas. It provides one of the most valuable sources of comprehensive factual information available for planning in metropolitan communities.

The development of methods for measuring highway capacity is the result of years of research and analysis by the Bureau of Public Roads and co-operating traffic and highway departments. Highway capacity methodology and formulas provide the basis for determining the adequacy of existing roads and the design of highways needed to carry and distribute traffic flow efficiently.

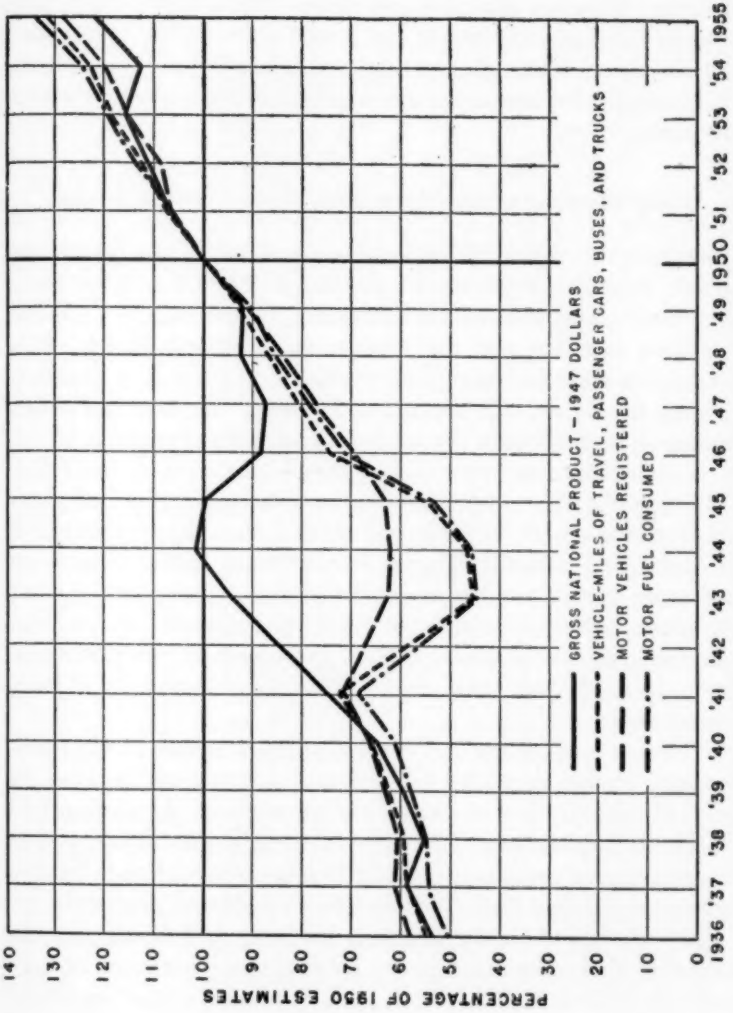


Figure 1. Comparison of Gross National Product and Highway Use.

These two developments are complementary instruments upon which we can and must rely for the facts on which to base solutions for urban transport planning and design. Without the other, each of these fundamental operations would suffer in its application and usefulness, although separately each has been responsible for increased effectiveness in the development of highways throughout the world.

Comprehensive Metropolitan Area Transportation Studies

More than 120 of the comprehensive travel-habit, and population surveys, in addition to many of more limited types, have been made since their conception by the Bureau in 1944. (Figure 2.) While providing accurate and useful patterns of present travel, many have fallen short of their potential value in providing means of gauging the future, not because of failure of the data but rather because of limitations in the scope and methods of analysis.

A useful tool was developed by correlating data on individual daily travel habits – obtained by home-interview traffic and population studies – with land use and other factors that generated or affected travel patterns. The value of relating traffic to land use and other factors for better understanding, interpretation, and estimation of urban population travel is evidenced by the outstanding results of analyses of data produced by comprehensive traffic studies in San Juan, Puerto Rico, Washington, D. C., and Detroit areas.

The current Chicago and the repeat Washington, D. C., transportation studies promise even greater contributions because the range of research into the relationships between population and trip generation has been widened by the use of electronic computers. This equipment permits the testing of more involved and comprehensive correlations than was heretofore considered practical.

The Bureau of Public Roads is studying and developing the potentials of electronic computers for testing the accuracy of various analytical methods of distributing estimated future interzonal movements within metropolitan areas. Results of this research should bring greater strength and stability to the projection of traffic movements in planning urban transportation improvements.

Figure 2. Location of origin and destination traffic studies conducted by state highway departments in co-operation with the U.S. Bureau of Public Roads.

Similarly, with these machines the tremendous volume of trip data relating to highway travel on state and national levels can be organized and analyzed so as to more expeditiously develop information regarding highway facility use and needs. Methods and procedures for this program, when fully developed and tested, should have considerable value in estimating future traffic on the interstate system.

Other research studies by the Bureau, particularly those analyzing data obtained from metropolitan area transportation studies, are in various stages of program development for application to the use of computers. These urban travel research studies are primarily for the purpose of gaining better interpretation and understanding of residents' daily travel habits so that planning for transportation and city growth is more realistic. These pilot studies already offer convincing evidence of the value of including land use, population density, income, and automobile ownership in forecasting residents' trip production. Indices have been prepared, from data in fifty cities, showing the patterns and changes in mode of travel as related to city population size. Studies are underway to develop methods for estimating the demand for various modes of travel within metropolitan areas. The ultimate product in terms of highway transport research is improved traffic forecasting.

Traffic Generation and Forecasting

The real key to traffic forecasting is the ability to estimate traffic generation. How much traffic will be generated by a new steel plant, by a government office building, by a housing development or a new shopping center? What transportation needs will result from urban redevelopment programs that replace slum areas of our central cities with new and improved housing and commercial developments? These are not hypothetical questions – engineers who must plan and design urban highways are confronted with them every day.

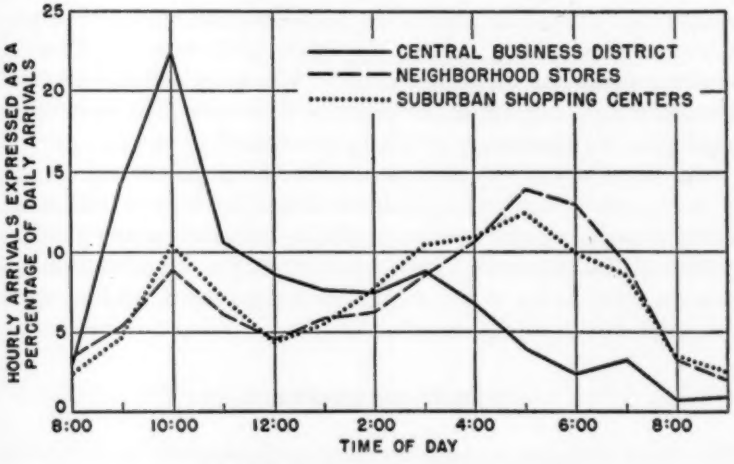
To answer such questions the Bureau some years ago began the study of trip generation by various types of land use. These studies had one significant characteristic different from previous analyses. They were primarily concerned with the volume of trips

destined to various types of generators as related to the geographic area of residence of persons making the trips.

Although trip origins are significant and were studied in part, for the purpose of these analyses they were of secondary importance. This emphasis on trip generation characteristics is perhaps easier to understand when we realize that cities are not static, but dynamic. There is a constant shifting and movement throughout all types of land-use within our cities – and not least among the places of residence of urban dwellers. Studies have shown that one out of every five persons changes residence yearly.

Essentially, our efforts should be to establish an orderly and balanced program of highway development in relation to the requirements of different parts of our cities. It is just as necessary to

TIME OF ARRIVAL OF SHOPPING TRIPS
MADE TO VARIOUS TYPES OF SHOPPING AREAS
Houston, Texas



SOURCE: *Houston Metropolitan Area Traffic Survey*—1953.

Figure 3

plan and design a complete highway system – including belt-routes or bypasses – tailored to an area's needs, as it is to prepare complete plans for any other structure or facility.

We are all familiar with the rapid and widespread growth of shopping centers, designed to cater to a suburbanized public, many of whom are so completely removed from the central markets that they are almost wholly dependent upon the outlying centers for their necessary goods and services. These centers have proved both boon and blight, depending upon the point of view.

Although tending to relieve downtown congestion, in too many cases highway service in the suburbs has been impaired and reduced by uncontrolled commercial development upon land adjacent to the public way – development which often constricts traffic movement. Figure 3 shows how peak traffic movements at suburban shopping centers occur during the city-wide evening peak traffic period – the very period from which our design hourly volumes are usually derived.

Effective co-ordination of the efforts of engineers, public officials, and private enterprises prior to the development of traffic-generating land uses can materially increase the ability of highways to operate at maximum efficiency with resultant savings in time, money, and even lives. It is not enough to study only the effects of land use upon our highway capacity. We must also endeavor to develop indices regarding the effect of these new highways upon population distribution and subsequent uses of the land.

All over the country the spread of urban population gives rise to entire new communities, often accompanied by new industrial plants, along our highway systems. We have seen these new growths in Bristol, Pennsylvania, in the outskirts of Los Angeles, Detroit, Houston, and other major cities, on Long Island, and now on industrial sites in mid-peninsular Florida.

Traffic and Land Use

The value of highway improvement is illustrated by economic studies of highway impact reported by California, Oregon, Texas, and other states. These studies are necessary and should be continued, but on a broader base as new major highways are built, particularly in the vicinity of interchanges along routes of the 41,000-mile interstate system. Moreover, they should be expanded to include not only an evaluation of the historical effect upon land

values, but also upon land development and the concurrent analysis of the traffic services rendered as well. Only in this way can we begin to estimate the effects of such developments upon our future highway plant.

Just as various sizes and types of commercial and industrial enterprises generate different amounts of travel, so also do residential areas. A Bureau of Public Roads study of selected residential districts in the Washington area demonstrated that there are definable variations in trip production by residents of these diverse types of neighborhood. These data are valuable in estimating the volume and characteristics of trips generated not only by new suburban housing projects, but also by renewed and redeveloped portions of our older urban areas.

Such data are essential in making forecasts of future transport and highway needs. However, forecasts are never factual in themselves; they are estimates by professional personnel using a mixture of facts, trends, and assumptions to project the present. These forecasts must be re-evaluated periodically, if we are to improve the methods and data upon which we must rely, not only for initial plans and design, but to meet and anticipate changing conditions.

If we are to preserve the existing amenities and the investment in time, money, and services now being expended, we must have greater knowledge of the effects of these highways upon urban areas, and consequently upon the traffic services provided.

Many tools and techniques are needed to plan, design and build a modern highway, particularly in urban areas. By the same token, long-sustained co-operative effort by many individuals and organizations is required.

Highway Capacity Evaluation

Just as important as knowing how much traffic to expect is knowing the ability of highways of different designs and characteristics to accommodate this traffic. Highway capacity studies are basic to successful planning and should have much greater public recognition. Highways do have maximum limitation in traffic capacity and when possible capacity is reached, traffic speeds and volumes are drastically reduced.

Figure 4 shows the depressing effect of traffic overloads on highway capacity. After capacity has been reached, attempted use of a facility by additional drivers only results in slower speeds and

RELATION BETWEEN AVERAGE TRAVEL TIME AND TRAFFIC VOLUME ON A 2-LANE RURAL HIGHWAY HAVING A POSSIBLE CAPACITY OF 2000 VEHICLES PER HOUR UNDER FAVORABLE OPERATING CONDITIONS

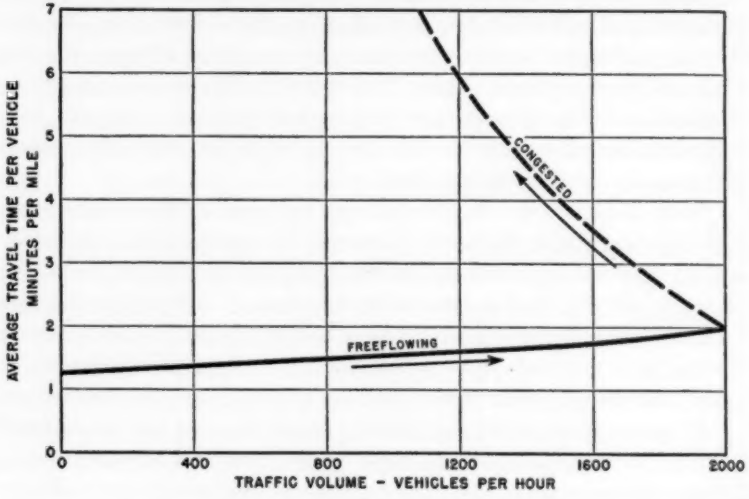


Figure 4

hence reduced volumes within a unit of time. So long as the volume is below possible capacity, travel time is less than two minutes per mile. Once the highway becomes congested, however, travel time is sharply increased and the volume drops rapidly.

The value of highway capacity studies and comprehensive travel-habit studies is well established, but these alone are not sufficient to solve major transportation problems in our cities. They in turn must be supported by continuing traffic-volume counts on all arterial streets and highways. And we must inventory these same streets and highways to know what facilities exist, to estimate their useful lives and the investment made in them. We also need to know more about the rate of traffic growth and land improvements.

The need for continuing city highway planning surveys should be obvious. They are as essential to urban areas as the now familiar statewide highway planning surveys. These are integral functions of state highway departments and provide the reliable data upon which our state and national highway programs are based.

In too many present instances we face the possible necessity of having to plan and design urban expressways without facts based upon continuing study. Perhaps our most important problem in the planning field is the co-ordination of highway planning with city and regional planning in and around urban areas. Highway construction under the interstate program alone within the years ahead will have a profound effect on the growth and development of urban areas for many years to come.

Fortunately this problem is receiving widespread attention. The National Committee on Urban Transportation, the Joint Committee of the American Municipal Association, the American Association of State Highway Officials, and the Committee on Urban Research of the Highway Research Board are actively attacking it from different directions.

That sort of co-operative effort we shall need in the months and years ahead. Let us remember that during this formative period we are not only planning highways, we are shaping a way of life for all America.

Planned Access-Control Keeps Our Highways Young

CHARLES W. AHNER

Mr. Ahner is Vice Chairman of the State Highway Commission of Wisconsin. His professional field is urban mass transportation. He was superintendent of interurban bus lines of a public utility corporation, and later purchased and operated urban bus companies in Janesville and Fond du Lac, Wisconsin, until his sale of the companies prior to his appointment to the State Highway Commission in 1953. A study of the mass transportation industry in Wisconsin by a state-wide committee under Mr. Ahner's chairmanship is widely known.

UNTIL recent years, property fronting along a highway enjoyed relatively complete freedom of access. Restricted access probably was first practiced in urban areas under local ordinances that set up standards for access points and driveway width. Subsequently, similar limitations on access were invoked in rural areas and this concept was expanded gradually to controlled-access highways and ultimate freeway development.

As it became clear that the public could ill afford the luxury of successively more frequent and more expensive highway relocations to provide satisfactory facilities for the traveling public, the quest for curing this uneconomic practice eventually led to the idea of controlled-access highways. In many cases, these were old roads converted as far as practicable to a controlled status to avoid wasting public investment in the existing highways.

These experiments in access control became impressive examples of proper design and visible demonstrations of controlled-access benefits. Motorists quickly adopted these new and safer highways – with fewer intersections, stoplights, and less marginal interference – and the demand for them grew rapidly.

Likewise, the highway engineer, confronted with the problem of moving an increasingly fluid public, realized that access control was a necessary feature if highways were to be more effective, and were protected from functional obsolescence. Toll roads and their

notable success in attracting motorists gave further impetus to the need for controlled access.

About 6,300 miles of toll-free highways in the United States have access-control features and are variously designated as expressways, limited- or controlled-access highways. This mileage is destined to increase many times as current national and state highway programs get under way. Standards for the 41,000-mile interstate system contemplate that all sections will be access-controlled and will have grade separations to carry crossroads over or under the routes of the system. Control of access is now an accepted concept and tremendous economic loss would result if either a compromise with the standards or abandonment of the controlled-access principle should take place.

The current concern with freeways, interstate highways, and toll roads has focused attention on them to the point of causing fear in many quarters that the seeming concentration on these roads may be detrimental to over-all highway development. In general such fears will prove to be unfounded; nevertheless the emphasis on interstate and other high volume roads may tend to overlook or depreciate the application of access-control to all state highways.

If the advantages of controlled access to the interstate and similarly important highways are as obvious as claimed, it follows there must be virtue and benefit in carefully planned and limited access for all state highways. It would seem logical and justifiable to use similar measures to protect the public investment in the ordinary highways so important to the economy of any state. With the knowledge and skills now available to highway planners, it should be possible to lay out roads of reasonably permanent location with design standards adequate to insure that the roads will be serviceable indefinitely.

Wisconsin's Enabling Legislation

Wisconsin's share of the interstate system totals approximately 452 miles in the general locations shown in Figure 1. Passage of the Federal-Aid Act was anticipated in Wisconsin and state assenting and enabling legislation was passed in 1955, months before federal legislation was enacted. No additional state legislation was re-

quired to take advantage of federal-aid provisions and consequently no delays because of lack of statutory authority were encountered.

Figure 1. National System of Interstate and Defense Highways in Wisconsin.

The Wisconsin law has among other provisions these salient features:

1. It assents to the acts of the United States Congress with regard to authorization and development of the national system of interstate highways.

2. It authorizes the appropriate state boards, commissions, departments, and governing bodies of counties, cities, towns and

villages, and especially the state highway commission, to co-operate in the planning, development and construction of the interstate system.

3. It empowers the state highway commission with full authority to lay out, construct, operate and maintain such highways as state trunk highways.

4. It permits the commission to make, or cause to be made, changes in location, lines and grade of existing public highways, railroads, and public utility transmission lines and facilities.

5. It specifies in case of highways on new location that no right of access shall accrue or vest in property owners; and if the highway is built on existing location, frontage roads must provide access or access rights must be purchased.

6. It makes the action of the commission relative to establishment, layout, location, or relocation of any part of the interstate system conclusive.

7. It empowers and authorizes the commission to construct grade separations at any intersections of highways and railroads, and to change and adjust lines of public highways, combine or relocate same.

8. It provides that the commission may by agreement with a county or municipality or by order summarily vacate or relocate any town, county, city or village highway as part of construction of an interstate highway. Action of the commission relative to vacating, relocating, or combining shall be conclusive.

9. It specifies that all powers granted in the section shall be liberally construed in favor of the state in furtherance of expeditious and orderly construction.

10. It provides that interstate highways by adoption of a resolution or order may be designated as expressways or freeways, but no previously existing public highway shall be so converted without acquiring access rights of abutting owners.

Under the authority granted by this legislation the commission was able to proceed promptly with advance planning, location, and aerial survey work. As soon as agreement on control points was reached with the Bureau of Public Roads, route location studies were begun. As a result, an aerial survey contract is in force for

every mile of Wisconsin's rural interstate system. Furthermore, it has been possible to establish all the access points and the type of access for the entire 420 miles of rural mileage. There will be 110 interchanges averaging a little less than four miles apart.

These interchanges will, of course, vary with the area traversed. In heavily populated sections where many state trunk highways cross the interstate system the interchanges will be much closer; for example, the section between the Illinois state line and Milwaukee, a distance of twenty-six miles, will have thirteen interchanges, approximately one every two miles. A diagrammatic sketch of this layout is shown in Figure 2. By way of contrast, on the sixty-mile section between Eau Claire and Hudson traversing less densely populated area, only thirteen interchanges are planned, or one every four and a half miles.

Details of the urban sections of the interstate system are in the plan stage and there is not yet enough information to permit an elaboration of the interchange points. The problems of access in urban and metropolitan areas are extremely complex, and access points to the system will be closer than in rural areas. Access-control determination is primarily the responsibility of the Milwaukee Expressway Commission and the City of Milwaukee; in general, the layout will conform to the expressway plans for the area as tentatively approved by the state highway commission and the Bureau of Public Roads.

Law on Controlled Access

In addition to full control of access under the interstate highway law, control of access has been permissible under a statute enacted in 1949. The law permits the commission to declare any section of highway a controlled-access highway following a public hearing in the prescribed manner. Originally a limit of 500 miles was provided, but 1955 legislation increased the permissible mileage of controlled-access highways to 1,500 miles.

Under this authority the commission may designate as controlled-access highways the rural portions of the state trunk system on which, after traffic engineering surveys, investigations and studies, "it shall find, determine and declare that the average traffic

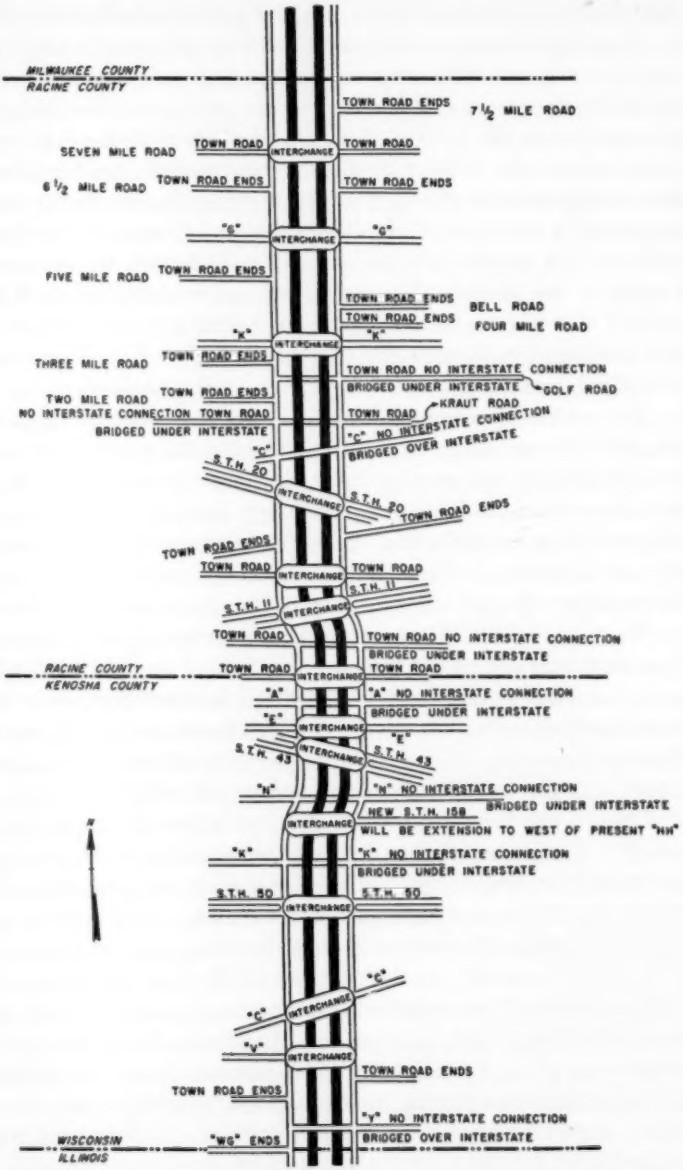


Figure 2. Diagrammatic sketch of interstate system in Wisconsin through Kenosha and Racine Counties.

potential is in excess of 2,000 vehicles per twenty-four-hour day."

A public hearing must be held in the county courthouse or other convenient place following due notice and publication once each week for three successive weeks in a newspaper having general circulation in the county. Upon completion of the hearing the commission may make a finding, determination, and declaration that designation of the highway as a controlled-access highway is necessary in the interest of public safety, convenience, and general welfare, and specify the character of the controls to be exercised. Copies of the finding, determination and declaration shall be recorded with the register of deeds and filed with the county clerk and published in the newspaper in which the notice of hearing was published, and the order is effective on such publication.

Thereafter the commission may use an existing highway or provide new and additional facilities and so design the same and its appurtenances and so regulate, restrict or prohibit access to or departure from, as deemed desirable or necessary. After the establishment of a controlled-access highway no street or highway or private driveway shall be opened into or be connected to it without the previous consent and approval of the commission in writing.

No person shall have any right of entrance upon or departure from or travel across the highway, or to and from abutting lands except at places designated or provided for such purposes. Moreover, abutting owners or occupants shall have no right or easement of access by reason of the fact their property abuts on the highway, except only the controlled right of access and of light, air and view.

Other important features of the law allow the commission to permit a special crossing at a designated location to be used solely for travel between severed parcels, and such use shall cease if the severed parcels pass into separate ownership. Any land or other private or public property or interest in such property needed may be acquired to carry out the purpose of the law. The commission is also authorized to enter into co-operative agreements with cities, towns or villages and counties, and the federal government concerning the planning, establishment, improvement, maintenance, use, regulation or vacating of controlled-access highways, or other public ways in their respective jurisdiction. Similar authority is granted for providing local service roads in connection with any controlled-access highway.

The law forbids the establishment of any commercial enterprise on or within land acquired for a controlled-access highway. It is also unlawful for any person to drive any vehicle into or from a controlled-access highway except through an opening provided for that purpose and penalties of a fine and imprisonment may be imposed on violators.

A controlled-access highway can be vacated by an order of the state highway commission, except that in cases where a state route is discontinued the controlled-access status is summarily vacated. Formal notices of any vacation must be filed with the register of deeds of the county wherein such highway lies.

It can be seen from the résumé of controlled-access provisions that the commission has comprehensive authority under the law. Although the commission could establish controls comparable to those permissible under its interstate highway authority, it has not thus far chosen to do so. Since many of the controlled highways were on existing locations and the principal purpose of the control was to prevent any further deterioration from proliferating access points, the commission adhered to a policy of recognizing authorized access drives in existence at the time of the declaration. In other words, the action of the commission results in a "freezing" of the access status, through its policy of not granting any additional accesses.

The commission has established 383 miles of controlled-access highway by administrative determination. About 322 miles, or 84 percent, are on the state's 2,200 miles of roads of principal traffic attraction, established by legislation as the state arterial highway system. The commission has proposals for the addition of 675 miles of controlled-access highway of which approximately 261 miles are on the arterial system. As a matter of policy it is proposed that all relocated highways will be established as controlled-access highways either by administrative determination of the commission or by acquiring access rights.

It is wise to avoid the use of both methods on the same section of highway. Recent experience indicates that the complications from the combined use of the police power and the purchase or negotiation of access rights, can be embarrassing and difficult to live with. The purchase of access rights – partial or complete – and the denial or control of access under the police power on the same highway are incompatible.

Another method of access control which the commission has used, particularly on newly improved state trunk highways, is the acquisition of partial or complete access rights from adjacent property owners by agreement and under eminent domain. In some cases on entirely new location where no previous rights of access for abutting property owners existed, complete access rights may be acquired; but usually some access to the highway is permitted in accordance with a general plan for the entire section of highway. Except for the stipulated access, all remaining rights of access are acquired.

Authority to Acquire Access Rights

In acquiring these access rights, the commission normally proceeds under broad authority of the statutes which provide that "The state highway commission may acquire by gift, devise, purchase or condemnation any lands . . . or interests in lands . . . may convey such lands thus acquired and not necessary for such improvements, with reservations concerning the future use and occupation of such lands so as to protect such public works and improvements and their environs and to preserve the view, appearance, light, air and usefulness of such public works."

This procedure offers several advantages. By this method, the commission is able to establish controlled-access highways by the sum of individual parcel acquisitions without the time-consuming proceedings required to establish controlled access on the highway by hearing, declaration, and finding. In effect, the commission is able to achieve desirable control of access for additional mileage of highways in excess of the 1,500-mile limitation imposed by the controlled-access highway statute.

Under this procedure it is possible to restrict the number of driveways to those required for present and potential use, and thus establish an acceptable pattern of access to the highway now for the future. Of course, the highways accorded this treatment will have the same protection afforded under controlled-access procedure with this additional safeguard: since access rights are purchased and conveyed by the property owners, the arrangement is permanent and is not subject to the vagaries of politics that might

possibly result in the repeal of the controlled-access legislation.

Approximately 190 miles of highway have been controlled through the purchase of access rights, of which about 150 miles are part of the state arterial system. A recent example is a 12.7-mile section of U. S. 45 in Oneida and Langlade Counties on new location. In that span of rural mileage the number of permitted access points totals seventy-five for both sides of the road or an average of six driveways per mile. This spacing of driveways is adequate for the type of highway and the volume of traffic on the road.

Another example is state trunk highway 57 in Ozaukee County, a more urbanized area. In this case, about fifty-one access points were permitted in 8.6 miles of relocated highway, or an average of about six per mile for both sides of the road. Remaining access rights were negotiated for or condemned at the nominal figure of $1.00 per parcel of property.

Driveway Regulation

The commission has exercised for a number of years the authority of driveway control. Under the law every opening into a state trunk highway, whether a private driveway or a public highway, must be authorized under a permit following application of the party involved. In general, the regulations specify that the applicant represent all parties in interest and that the driveway or approach be for securing access to property and not for parking or servicing vehicles, nor for advertising, storage, or merchandising goods on the highway right-of-way.

The driveway must be installed by the applicant at his expense and in a manner and location designated, subject to the approval of the district engineer. No revisions or additions to the driveway or its appurtenances on highway right-of-way can be made without written approval. The commission, however, reserves the right to make such changes, additions, repairs and relocations as may be necessary to permit the relocation, reconstruction, widening and maintaining of the highway or to provide proper protection to life and property on or adjacent to the highway.

The location, design and construction requirements are specified in detail. The number of driveways serving a single property

frontage shall be the minimum deemed necessary by the district engineer for reasonable service to the property without undue impairment of safety, convenience, and utility of the highway.

Other pertinent requirements forbid direct ingress or egress to or from public highway intersection areas, and driveways shall not encroach on or occupy areas of the roadway or right-of-way deemed necessary for effective traffic control or for highway signs or signals. The location and construction of a driveway shall be such that vehicles approaching or using it will have adequate sight distance in both directions along the highway.

Specific construction and layout details have been set up for four classes of driveways: commercial-rural, noncommercial-rural, commercial-urban and noncommercial-urban. These include such features as width of drive, return radii, angular placement of driveways, and island areas.

In general, administration of these provisions is designed to minimize entrances to the highway. Permits are issued only after a careful field inspection of the proposed location and study from the safety, traffic movement, and drainage aspects. The issuance of permits is also co-ordinated with controlled-access highway and land-subdivision regulations to avoid possible conflicts.

An allied endeavor toward achieving better access control to state highways has been underway for the last two years and is now essentially completed. This program's purpose is the proper delineation and reconstruction of driveways which do not now conform to the regulations. Many driveways had been in existence since the original location and did not conform to the recent regulations on width, location, drainage, or other requirement. Also, a number of driveways were not covered by a permit required by law.

Some long-established driveways were discovered to be in such locations that servicing of vehicles and merchandising were being conducted, often inadvertently, on the highway right-of-way. In certain sections of the state, right-of-way records were not existent or were not clear as to the exact takings. In earlier days the importance of records was overlooked, and often land was acquired by donation. For similar reasons, knowledge of right-of-way width in those areas is obscure.

Under systematic procedure these irregular situations were cleared up by staking out of the right-of-way and using control

measures to effect conforming installations and orderly ingress to state highways. In many cases, it was necessary to delineate driveways with posts to prevent indiscriminate and uncontrolled entry to the driveway. At some locations slight rearrangement and better delineation of highway ditching served the same purpose, as shown by the before and after sketches of Figure 3.

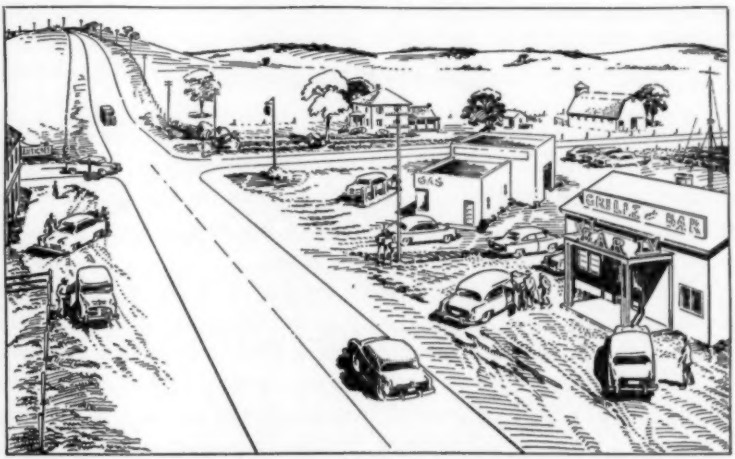


Figure 3A. A typical rural commercial development on an older state trunk highway with narrow right-of-way.

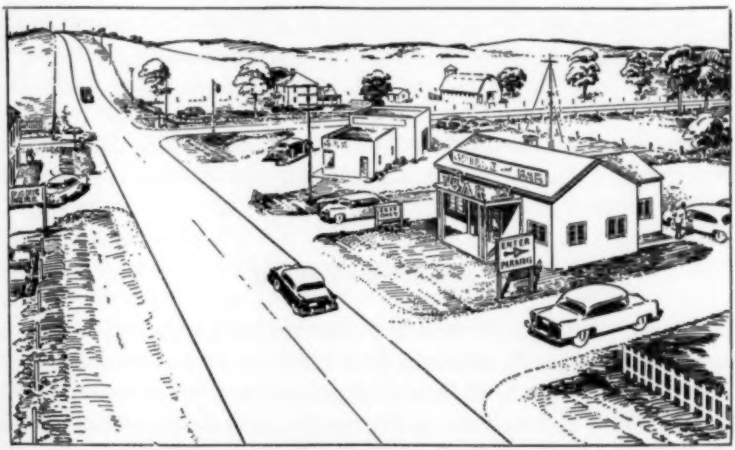


Figure 3B. After improvements in driveways, parking areas, and drainage, appearance is neater and traffic is safer.

A device used in specific situations is the regulation or control of private driveway use, particularly in connection with purchase of access rights. In many cases, the regulation of driveway use is included in the transactions when access rights are acquired. When complete prohibition of access is not necessary, access rights of the property owner are often restricted as to quantity, location and use of the owner's remaining land.

Control of Driveway Use

Driveway use is usually restricted to one or more of the following purposes: (1) private residential use; (2) agricultural use; (3) for operation of an existing (described) activity on the grantor's remaining land; and (4) for operation of future specifically named activities on the grantor's remaining land.

These restrictions on use may be acquired by agreement or under eminent domain. Acting upon the authority granted in the statutes, the commission adopted and added to deeds for acquired lands, clauses for conveyance of access rights and restriction of access use. The form of these clauses consists of a grant, relinquishment and waiver of "all existing, future, or potential common law or statutory easements of access" between the right-of-way and all of the grantor's remaining contiguous land.

In view of the direct relationship of vehicular movement to the kind or purpose of use of highway accesses, benefits from this control are appreciable. Restrictions on driveway use affect the frequency of use and thus judicious resort to such control at selected locations can result in minimizing traffic hazards, permitting freer traffic movement, reducing accident potential, and eliminating the possibility of reduced speed zones.

Subdivision Control

The most recent addition to the commission's authority concerns the platting of lands adjacent to a highway or connecting street. The purpose of land-subdivision regulations is "to promote public health, safety and welfare; to further the orderly layout and use of land . . . to lessen congestion in the streets and highways; . . . to provide for proper ingress and egress . . ."

Under the requirements of the statute, the commission must formulate "rules relating to provision for the safety of entrance upon and departure from the abutting state trunk highways and connecting streets, and for the preservation of the public interest and investment in such highways or streets." The required regulations were drafted with the guidance of a representative group of city and county planners, surveyors, and real estate men; after a public hearing, the rules were published and became effective. Standards were simple and few in number:

1. There shall be no direct access between the state trunk highway and the individual lots or parcels in the subdivision without the express consent of the commission.
2. When deemed feasible, frontage roads or a satisfactory alternative will be required.
3. The subdivision shall be laid out with a minimum number of street connections with abutting state trunk highways. In general, a distance of at least 1,000 feet between intersections will be required.
4. Subdivisions shall be so laid out that the individual lots or parcels do not require direct vehicular access to the highway.
5. Whenever existing streets provide reasonable and adequate access to a state trunk highway, the streets in a subdivision shall not be opened directly into a state highway.
6. There shall be a minimum building setback 110 feet from the centerline of the state trunk highway, or fifty feet outside the nearer right-of-way line, whichever is more restrictive.

A land subdivision plat showing the type of access control affected and other required features is shown in Figure 4.

All plats abutting a state trunk highway must be submitted to the commission for review. Although not an approval body under the law, the state highway commission may file an objection within twenty days from the date the proposed plat is forwarded. If the plat does not comply with requirements, the commission files an objection with local authorities indicating the reason for noncompliance. No plat may be legally recorded until the objections have been satisfied.

Although administration of the platting law is still limited, the commission is convinced that highway administrative agencies

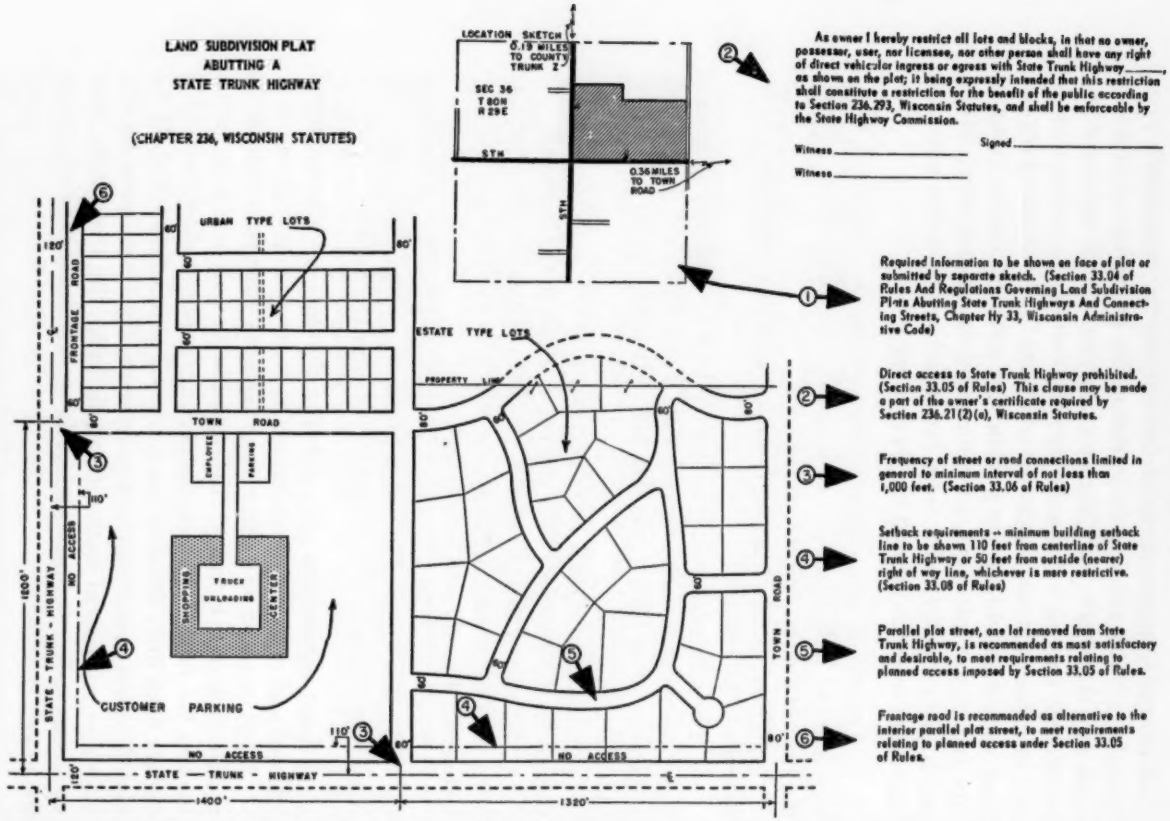

LAND SUBDIVISION PLAT
ABUTTING A
STATE TRUNK HIGHWAY
(CHAPTER 236, WISCONSIN STATUTES)
LOCATION SKETCH
0.13 MILES TO COUNTY TRUNK Z
SEC 36
T 8 ON
R 29 E
STH
0.36 MILES TO TOWN ROAD
As owner I hereby restrict all lots and blocks, in that no owner, possessor, user, nor licensee, nor other person shall have any right of direct vehicular ingress or egress with State Trunk Highway _____, as shown on the plat; it being expressly intended that this restriction shall constitute a restriction for the benefit of the public according to Section 236.293, Wisconsin Statutes, and shall be enforceable by the State Highway Commission.
Witness _____ Signed _____
Witness _____
URBAN TYPE LOTS
FRONTAGE ROAD
TOWN ROAD
ESTATE TYPE LOTS
PROPERTY LINE
EMPLOYEES PARKING
SHOPPING CENTER
TRUCK UNLOADING
CUSTOMER PARKING
NO ACCESS
STATE TRUNK HIGHWAY
1400'
1320'
1600'
110'
120'
80'
60'
Required information to be shown on face of plat or submitted by separate sketch. (Section 33.04 of Rules And Regulations Governing Land Subdivision Plats Abutting State Trunk Highways And Connecting Streets, Chapter Hy 33, Wisconsin Administrative Code)
Direct access to State Trunk Highway prohibited. (Section 33.05 of Rules) This clause may be made a part of the owner's certificate required by Section 236.21(2)(a), Wisconsin Statutes.
Frequency of street or road connections limited in general to minimum interval of not less than 1,000 feet. (Section 33.06 of Rules)
Setback requirements -- minimum building setback line to be shown 110 feet from centerline of State Trunk Highway or 50 feet from outside (nearer) right of way line, whichever is more restrictive. (Section 33.08 of Rules)
Parallel plat street, one lot removed from State Trunk Highway, is recommended as most satisfactory and desirable, to meet requirements relating to planned access imposed by Section 33.05 of Rules.
Frontage road is recommended as alternative to the interior parallel plat street, to meet requirements relating to planned access under Section 33.05 of Rules.

Figure 4. Land subdivision plat showing state highway commission controls over plats abutting a state trunk highway.

must have the authority to control highway access from subdivisions if they are to preserve the traffic capacity of highways and the public's investment in them. Uncontrolled subdivision expansion is a threat to safety and orderly traffic movement, and a contributing factor in abandonment of highways hemmed in by indiscriminate development and cluttered roadsides.

Public acceptance of platting control has been good and most land subdividers are co-operating because the regulations and administration assure equal treatment for all. Moreover, the platters realize that proper layout and access control afford protection to subdividers and property owners alike against abnormal deterioration of the area and possible highway abandonment.

Zoning and Setbacks

A complementary control is provided under zoning authority. To achieve the ultimate in efficient traffic movement and safety and protect investment in highways, a properly developed land-use plan is required – especially for areas adjacent to state highways. Thus far the Wisconsin legislature has not favored giving the commission such authority. Counties and towns have been granted the power to zone, however, and some zoning has been accomplished in several areas.

Interest in zoning has increased in recent years and more counties adopt zoning ordinances each year. At last count forty-five of the state's seventy-one counties had some form of zoning as follows: twenty-six counties have a county-wide comprehensive zoning; fifteen provide for agricultural and industrial zoning only; and four counties have merely established a building setback line.

The setback provisions of these ordinances have particularly benefited the commission, and if such building setbacks could be established in all counties it would help to protect investments in right-of-way and prevent the cluttering of adjacent areas with buildings. Setback requirements differ widely in counties but the most common is a setback restriction of 110 feet from the highway centerline, or fifty feet outside the nearer right-of-way line.

Whenever the commission disposes of land no longer needed for highway purposes, it is usually sold to adjacent owners or other interested parties. In all cases, except when it is impractical, restric-

Figure 4. Land subdivision plat showing state highway commission controls over plats abutting a state

tions on the number of access points to the highway are included in the deed to the property. In many cases – because of the location – property is sold without any right of access to the highway. Restrictions concerning advertising signs are often included.

Freedom of access to public highways in this country is well established in principle and practice. Only in recent years has any significant progress been made in altering this age-old concept. Many states now have some form of controlled-access highway legislation; in fact, only a handful of states are without this legal and administrative tool.

Now that federal law requires control of access for the interstate system, it can be expected that all states soon will be equipped with this authority. Although legislation permits access control in nearly all states, many states apparently have not used this authority to date and consequently have no experience in this area.

Need for Public Relations Program

It is not surprising, therefore, that so much opposition to this principle has been expressed. From national reports, the attempts to translate the authority into practice have on occasion stirred up a veritable hornet's nest. This condition indicates a failure in public relations. Obviously, the way has not been well prepared in acquainting the public with this new concept.

As a result, the misinformed opposition has resisted, if not thwarted, the highway departments' efforts toward effecting access control. A tremendous public relations and information effort will now be required to offset the damage already done and overcome resistance to extension of access control.

Experience in Wisconsin has been reasonably successful and progress toward public acceptance has been encouraging. Several factors are responsible for accomplishments to date. Opposition, of course, is always local, but it should never be ignored or underrated. The Wisconsin state highway commission, by law, customs, and tradition, works closely with the counties; local highway officials are normally advised and well informed in matters of mutual concern. This liaison establishes confidence and frequently results in assent and co-operation of local authorities – a fundamental step in obtaining support and overcoming objection. Long-established

relationships in Wisconsin prepare the way for local agreement.

By law the commission is required to hold public hearings on such matters as control of access and highway relocations. As a practice, the commission holds hearings even when there is doubt that one may be required by the statutes. In conducting a hearing the commission lets everyone who wishes to be heard make his presentation. To the extent possible every question raised is answered, even though the question may not be germane.

Thus the commission avoids the criticism frequently made that persons who attended the hearing were not permitted to express themselves. Admittedly this practice leads to lengthier sessions, but the advantages in good will and public confidence far outweigh the disadvantages.

Extra effort, of course, must be put forth in promoting any new concept, particularly one so misunderstood and misrepresented as control of access. However, the job of selling has been made much more difficult because of the unfortunate designation "controlled access." To a large segment of the public "control" is anathema, and it seems that opponents have adopted control of access as their watchword. Controlled-access application might have fared better if legislation and literature had used more acceptable terminology. For example, "planned access" has a better connotation and conveys a more palatable and salable idea.

Despite normal obstacles and opposition, the Wisconsin commission has been able to establish controlled-access highways in thirty-two of the seventy-one counties of the state. Acceptance on the part of the public has been good; actually, serious opposition has been localized in one county.

It may be that not enough has been done to prepare the public for accepting this restriction on individual freedom for the common good. Perhaps inadvertently, too much emphasis has been placed on control and too little attention given to the advantages and benefits to the general public – and the special benefits to abutting property owners. Efforts must be renewed to overcome public opposition because no program can be successful without public understanding and co-operation.

Not only must highway authorities protect interstate highways and major traffic arteries, but they must apply access-control principles to all state-administered highways – particularly to new high-

way locations. Many states may not have the necessary authority and legislation to deal with the problem adequately, but the time is ripe for comprehensive planning to bring about this objective.

As motorists travel on expressways, freeways, and similarly controlled highways, they will become more conscious of the need for extending access limitation to more mileage of state highways.

Control of access is here to stay, and shortly in a majority of the states it will be an activity of major importance in highway departments. Achievement of maximum results will require proper staffing and organization, and co-ordination of the several highway department sections, including right-of-way, design, construction, and maintenance. Because of its far-reaching implications and effects, access control should not be regarded as a nuisance activity.

More attention to the problems of planned access is requisite to an orderly development of a highway transportation system. Procurement of wider rights-of-way in itself will not prevent a repetition of past experiences with functional highway obsolescence. Only by the application of access control principles will highways be insured against such uneconomical and unwarranted end.

The public can no longer afford the luxury of administrative indecision on a matter so important to public welfare. Highway administrators can no longer justify inaction by claiming ignorance of the cause of functional obsolescence, nor can they be excused for failure to make use of the tools available to prevent such development. If not properly equipped to do the job that needs to be done, the administrator should request the necessary authority from the legislature. It seems useless and wasteful to build expensive highways and not be able to provide minimum protection necessary to preserve one of the nation's greatest assets.

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Transportation and Parking Facilities In Downtown Rehabilitation

FRANK EMERY COX

Mr. Cox is a sales research and business development analyst in Berkeley, California. Widely experienced in sales promotion, public relations, advertising, and market research, he was formerly associated with the California State Department of Business Education. Mr. Cox has traveled extensively on the North American continent and in the Pacific Islands, studying trends in urban development. He has made more than one thousand talks before chambers of commerce, real estate groups, and publishers' associations. He has also contributed articles to many magazines on downtown property preservation and related topics.

A RECENT survey in a midwestern city encompassed the interviewing of more than 15,000 separate householders in all parts of the city and in all brackets of income and social strata. Using the highest and lowest income levels on the schedule and recognizing that deviations in the other income brackets are not materially apart, study analysts found the following a good indicator of what people think of the area usually referred to as "downtown" or the central business district.

	Percentage of Answers Family Income Level	
They Liked Downtown Because:	*Under* $3,000	$7,500 *and over*
Larger selection of goods	51.7	66.9
Cheaper prices	13.8	8.4
Convenient public transportation	6.9	5.7
Enjoyable place to shop	—	2.6
Close to home	6.9	0.7
Stores close together	—	0.7
Can do several errands at once	13.8	4.5
Better delivery service	—	0.7
No advantages	6.9	6.5
No data	0.0	0.0
Other	0.0	3.3
	100.0	100.0

	Percentage of Answers Family Income Level	
They Do Not Like Downtown Because:	*Under* $3,000	$7,500 *and over*
Poor public transportation	17.3	8.4
Takes too long to shop	10.3	5.9
Difficult parking	34.5	51.3
Too crowded	13.8	9.7
Congested traffic	0.0	9.1
Cost of transportation too high	0.0	0.6
Too far to go	0.0	1.3
Unfriendly service	0.0	2.3
Other	6.9	2.9
No disadvantage	13.8	5.9
No data	3.4	2.6
	100.0	100.0

These results were comparable to a similar study by the Massachusetts Institute of Technology for the Boston area in 1954 and published in *Business Week*.

Let's compare all the income groups on certain phases of their likes and dislikes:

Buying Environment Advantages

Total of (a) Larger selection of goods
(b) Cheaper prices
(c) Enjoyable place to shop

Under $2,000	$2,000–2,999	$3,000–3,999	$5,000–5,999	$6,000–7,499	$7,500 *and over*
65.5	61.5	58.3	62.0	63.5	77.9

Fifteen thousand persons said they liked to trade in the central business district because of these three major buying environment advantages according to the percentages indicated above.

So parking seems by far the predominant disadvantage in people's minds as they think about patronage of the downtown area stores. In this latter grouping of disadvantages, the word "parking" means "automobile terminal facilities."

"Getting There" – Disadvantages

Total of (a) Poor public transportation
(b) Difficult parking
(c) Congested traffic
(d) Too far to go

Under $2,000	$2,000–2,999	$3,000–3,999	$4,000–5,999	$6,000–7,499	$7,500 *and over*
51.8	61.5	61.1	76.0	70.8	75.3
of which Parking represents					
34.5	30.7	41.7	47.1	38.6	51.3

No attempt is made to say how much parking is needed in any given area and certainly it would not be possible to say where this parking should be. Answers to these questions would have to be determined by an intimate survey of the areas involved. The pattern of streets, the physical barriers and handicaps existing, public transportation systems, the width of the thoroughfares, and many other factors would influence how much and where automobile terminal facilities should be.

It is essential and of utmost importance though, to recognize that:

a. A certain percentage of people prefer to shop in already established business districts if they can do it *almost* as conveniently as they can in a suburban center, *because they can "see more things."*

b. Suburban centers will probably never offer the same range of selection as central business districts, but they will take a large portion, depending on the composition of these centers and other conditions.

c. The central business districts are the mecca for "shopping goods" represented by department stores and specialty shops.

d. The keystone of bringing them to downtown is *adequate, permanent, low-cost parking* (automobile terminal facilities) including validation systems and freeways with adequate access streets leading to these parking areas.

If values of existing neighborhood shopping areas within the city are to be preserved, it becomes immediately necessary to recognize that the central business district must be kept inviting and dynamically glamorous enough to the buying public to make them prefer to shop in these neighborhood areas and the central

business district rather than go to a perimeter shopping center. This preference would have the effect of preserving the purchase of "convenience" merchandise for the closest neighborhood shopping districts – in much the same fashion that the pattern was formed in the past and that exists today – and of retaining the trade of "shopping goods" for downtown.

Neighborhood Centers Depend on CBD Survival

A definite relationship must be preserved between the central business district and the already established neighborhood shopping areas, if our existing commercial facilities are to survive. It has been proved impossible to maintain retail sales and property values in established neighborhood centers already in existence if a degeneration in retail sales and the subsequent deterioration in property values occur in the central business district. It therefore becomes paramount that a strong "pull" in the central business district be retained.

One of the most frequent questions asked today by thoughtful property owners, merchants, public officials and city planners is, "Can downtown central business districts maintain a position of economic solvency?"

When such staggering headlines appear in various publications as, "Traffic Congestion Causes Crisis," "Auto Congestion Found Increasing in Urban Areas," "Central Business District's Survival Lies in the Solution of Parking Problem," "Congestion Endangers Future of Urban Business," "Average American City Declared as Out-of-Date as Bell-bottom Trousers," it is quite generally conceded that the automobile, coming into general use by all Americans, has created this problem we now face.

The automobile to the average American today means as much as a horse means to a cowboy. It is not uncommon to find the car of the family receiving better care than the home. It is the average man's companion for his briefest errand – as well as for his wife's. Americans like automobiles as no other nationality.

In China, there is one car for every nine thousand inhabitants, and in Russia, one for every one thousand inhabitants. Great Britain has a ratio of one automobile for every twenty-six persons, but in the United States, we have roughly one automobile for every

five people. They do their errands by automobile; they shop by automobile; they live by automobile. The private automobile has become the usual means of transportation all over America.

It has supplemented the public transportation system to the extent that these public carriers now find themselves in difficulty. As patronage declines, the carrier is forced by necessity to increase its fares, and thus add more resistance to the public's use of the system. Consequently, a cycle develops that is definitely vicious. Shifting populations, newer shopping districts, increased traffic congestion and lack of adequate parking facilities in the central business district are the principal factors affecting downtown's ability to retain its position of dominance.

Decline in Downtown Retail Sales

Until the 1954 Census of Business, there were no statistics available to reveal any evidence of adverse forces at work. Recently, however, the Census Bureau released data that are quite alarming.

In forty-five large metropolitan areas, retail store sales rose 32.3 percent between 1948 and 1954, but sales in the downtown districts increased by only 1.6 percent. These large metropolitan areas accounted for 45 percent of all retail store sales in the United States. Their central business districts shared only 7.5 percent of this total, a drop from 9.7 percent of the 1948 national total.

A few examples from the report will pinpoint the problem to specific areas:

Los Angeles' metropolitan area showed an increase of 28.6 percent, while the central business district showed a decrease of 6.7 percent in retail sales.

San Francisco's metropolitan area sales increased 28.6 percent, while the central business district increased only half of one percent.

Pittsburgh's metropolitan area figures rose 15.1 percent, but sales in the central business district decreased 16 percent.

In Dallas, the increase in the metropolitan area was 58.9 percent, whereas the central business district showed a decline of 1.8 percent.

In San Diego, the figures were 57.4 percent increase for the metropolitan area and a decrease of .08 percent for the central business district.

Salt Lake City's metropolitan area gained 38.3 percent, as the central business district's sales decreased 2.1 percent.

All of these figures are in current dollar values and do not take into consideration the adjustments that have to be made to determine the unit sales volume and the inflationary factors.

It would appear that this condition is going to get worse before it gets better, largely because of the impact of regional and community shopping centers that are being opened in the suburban areas.

In September, October and November of 1956, a new record was established for the opening of large regional shopping centers in the United States. The seventeen huge centers beginning operation during this period each averaged as much square footage of store space as is usually found in the downtown areas of most cities of 100,000 population.

All of these centers contained more than 12,000,000 square feet of store space. Already in operation were those in the regional category containing approximately the same amount. In other words, the country's total retail space in large regional centers was doubled within a period of three months.

Fourteen other large centers are under construction and will open within the next eighteen months. They will contain another 12,000,000 square feet of store area and will no doubt syphon off millions of dollars in additional retail sales from downtown areas.

Need for Retaining CBD Solvency

The position of downtown districts grows apparently weaker each year, largely because of the decline in patronage of the stores located there. Retail stores in general – including those selling department store goods, apparel, and furniture – have lost ground as far as their over-all position is concerned. There seems to be little difference between the smaller cities and the larger ones. Indications are that during the next ten to twenty years the situation will become worse rather than better.

Now that the private automobile is the predominant means of transportation, traffic arteries and terminal facilities in the business areas become the major problem to consider. No longer can we

afford to temporize if our central business districts are to retain solvency.

There is no need for this condition to continue because the downtown areas have a great deal to offer. To date, however, too little effort is being put forward on a master plan basis to really correct the problems. The patient is receiving temporary palliatives rather than having a complete diagnosis with the ultimate objective of undergoing major surgery.

When a person has a serious ailment the first thing the doctor does is to diagnose its cause. His next step is to supply a form of treatment to overcome the malady. Quite often this treatment does not suffice and he has to resort to surgery. If this step is taken before the infection goes too far, the patient is saved. On the other hand, if the tissues have deteriorated beyond the point of redemption or correction, the patient dies.

A close analogy to this situation exists in the downtown section of a city, suffering from a condition that can definitely be termed malignant.

Evidence of this malignancy can be observed in the field of property values. The present increase in land values in the United States reveals the fact that most downtown areas have barely held their own in the value scale since 1947; or if they have shown increases, these have been slight when measured in constant dollar values.

For example, Chicago's downtown State Street frontage sold for as high as $25,000 a front foot in 1929; in 1947 it was priced at $14,000 to $15,000, and today is valued at $15,000 to $17,000 in inflated dollars. There are exceptions, of course, to these conditions in Chicago and in all cities, but the general trend of downtown districts is developing in a dangerous direction unless remedial action is taken.

It must be stated, however, that there is a difference in the rate of degeneracy in different parts of what we call downtown. Most downtown areas are becoming more compact with the 100 percent areas remaining fairly level in their values or even improving. It is in the fringe areas where values are decreasing rapidly and in many cases the areas are being used for other than retail purposes.

Too little time is available to accomplish renewal objectives in

the worn-out districts. Populations are growing so rapidly and transportation systems are undergoing such revolutionary changes that the patient, the central business district, has reached the point where treatment, in most instances, will not suffice and major surgery will be required.

Changing trends in our population add to the complexity of the problem. In the five years between 1950 and 1955, 156,000,000 persons in the United States changed their address. This is approximately 90 percent of our total population; and though it is hard to comprehend such figures, the U. S. Census Bureau released these statistics and upon them we must rely.

Cities of 50,000 or more are growing four times as fast as the rest of the country. Suburbs around these cities are growing six times as fast as the cities they surround. As this population deploys itself into the suburbs it is only natural that commercial facilities formerly supplied by the downtown districts are supplemented by similar ones on a scientifically planned basis, located close to where this tremendous growth is taking place. Furthermore, downtown districts in most communities are obsolete, worn out, ugly and inconvenient.

Stable Tax Base Is Keystone

It is impossible to blame the city hall for these conditions. It is the responsibility of individual citizens, property owners, and merchants, working in objective co-ordination with civic organizations and public officials to achieve proper results.

A most important phase of this degenerating trend is the effect on basic tax structures for urban communities. The modern system for assessing property taxes is predicated on the landlord's ability to earn a certain return from that property. It must therefore follow that if sales are reduced, the building that houses the establishment is unable to produce as much rent. With decreased rent, the landlord gets less return on his investment and he seeks tax relief on this basis.

If merchants have a reduction in sales, they carry less inventory than formerly, which means a further reduction in tax revenue. This chain reaction continues to the point where neither merchants nor property owners have any inducement to improve the property,

to add new and more efficient fixtures, and to increase inventories in search of expansion.

All of these things reflect themselves in the ability of customers to park. In today's declining use of public transportation, no driver of an automobile is a customer until he has parked his automobile and become a pedestrian with free access to the shops where he seeks to make purchases; and – as has been determined by those who create shopping centers – a person will walk only a limited distance to make his purchase.

This distance varies with the type of merchandise desired and the size of the area in which he is attempting to shop. Generally, to buy groceries in a business district section, the customer will walk not more than 150 feet; but as he goes into a central business district to buy at a department store, this distance will increase from 400 feet to three or four blocks depending on the size of the city, the appeal of the shopping environment, and many other factors.

Therefore, those factors that affect the tax revenue of a retail district and finally the entire city, rest on a foundation of traffic and parking. It should not be overlooked that a retail district is the nucleus which holds together such services as professional offices, banks, personal services, industrial and financial offices, company headquarters, and all the components of a complex urban economy because they too must rely on pedestrians in order to exist.

Decrease in Pedestrian Traffic

Recently, Oakland, California completed a study of the effect of diminishing retail sales on the tax revenue structure and its direct relation to the traffic and parking problem. All this can be called an approach to the rehabilitation or rather preservation of an existing important area in that city. The study was conducted for the Parking Committee of the Oakland Chamber of Commerce because of their concern over diminishing pedestrian counts in the central business area and the diminishing retail sales in Oakland, as a city, when those sales are interpreted in terms of units sold or number of transactions, rather than in terms of inflationary dollars that do not present a true picture.

Among other significant items was the alarming decrease in pedestrian traffic that occurred in most portions of the central

business district. A random look at these pedestrian counts as supervised by the city traffic engineer, is extremely significant. The five illustrations given below are for the primary shopping district of the downtown section of Oakland.

MID-BLOCK COUNTS 10 A.M. TO 12 A.M. AND 1 P.M. TO 5 P.M. ON DATE SHOWN

	General index	*West side Washington between 11th & 12th* (*Persons*)	*West side Washington between 13th & 14th* (*Persons*)	*West side Broadway between 17th & 19th* (*Persons*)	*West side Broadway between 20th & 21st* (*Persons*)	*West side Telegraph between 17th & 18th* (*Persons*)
October 1948 = 100						
April 1949	99.9	12,246	9,208	4,805	—	7,224
April 1952	85.5	7,250	7,774	3,878	4,328	6,334
May 5, 1954	80.9	8,132	6,665	4,144	3,593	6,861
May 16, 1956	58.5	4,346	4,495	2,672	2,825	4,285
May 1, 1957	62.8	5,498	4,640	2,712	2,869	4,021
October 1948 = 100		(*Index*)	(*Index*)	(*Index*)	(*Index*)	(*Index*)
April 1949	99.9	94.1	96.8	91.9	—	98.3
April 1952	85.5	55.7	81.7	73.5	72.1	86.2
May 5, 1954	80.9	62.5	70.0	78.5	59.9	93.3
May 16, 1956	58.5	33.4	47.23	50.6	47.1	58.3
May 1, 1957	62.8	42.2	48.7	51.4	47.8	66.9

The traffic engineer's office believes that the use of public transportation is approximately parallel to these figures.

So – to attract more people – more attention must be given to:

a. Caring for private transportation – which is the automobile.
b. A place to park it – with attention to permanent locations.
c. Easily accessible locations.
d. Adequate size.
e. Nominal charges.

What is happening in Oakland is typical of what is taking place in most of our cities' central business districts. In analyzing pedestrian traffic and the degree that it is shrinking, it is possible to show by the projections and past experience of another California city what is going to happen to sales – in view of the trend already set and the pattern of decreased pedestrian traffic – unless something is done to change the direction of this trend.

The index of retail sales, adjusted to the Bureau of Labor Statistics cost of living index for all items, reveals the following possible changes that may take place in the retailing picture:

1947 Sales	100.0 percent
1950 Sales	99.7 percent

1955 Sales	95.4 percent
1960 Sales (estimated)	89.75 percent
1965 Sales (estimated)	85.7 percent
1970 Sales (estimated)	80.33 percent

These adjusted figures remove inflationary elements and represent unit sales for that year rather than dollar volume.

An actual case, shown below, of 400,000 square feet of building area in the heart of a California city can be considered typical of what is happening. In this particular instance, the intent is to show the effect a typical retail area could have on the tax structure of the entire community if sales decrease.

The illustration is based on 25 percent of value for assessment purposes and the tax rate used is that which applied to the city in question, rather than the city and county rate. In this city a one percent sales tax is levied on all retail sales. The retail area analyzed is in the heart of the business district.

400,000 sq. ft. of retail buildings at $10 sq. ft. cost	$4,000,000
400,000 sq. ft. of land at $5 sq. ft. (market value)	$2,000,000
Total invested	$6,000,000

On this property, sales should be:

400,000 sq. ft. at $30 sq. ft.: $12,000,000

The Tax Picture

25 percent of market value appraisal for tax assessments: $1,500,000

If sales trend drops 25 percent, location value is reduced 25 percent:

Tax returns to the city:	(*Now*)	(*With sales drop of 25 percent*)
Real estate at $2 per $100	$30,000	$22,750
Personal Property (Inventory) $2 per $100 at 25 percent of value using 6 turns at 40 percent margin ($12,000,000 – 6)	6,000	4,500
Fixtures at 25 percent of value (no change)	8,000	8,000
Sales tax at 1 percent	120,000	90,000
Total tax return	$164,000	$125,250
Total loss to city	$ 38,750	
Of which loss	$ 30,000 is sales tax	

Eighty-three percent of this loss cannot be deferred by any manipulation of assessments or tax rates.

No other use of land can produce as much tax revenue *as a booming retail district.* Here is where the new perimeter shopping centers will hit the hardest–they intend to draw a major trade from downtown.

How this reduction in taxes would affect a city's entire tax structure is apparent in a hypothetical case based on factual information applying to an average city of 200,000 persons. In this case data are based on the needed tax revenue to support the city for a current fiscal year. The revenue would come mainly from the following sources:

Estimated sales and use tax	$ 3,500,000
Estimated real property taxes	6,000,000
Estimated personal property taxes	600,000
Estimated revenue from other sources	2,500,000
	$12,600,000

It can be seen that the sales tax would equal more than 25 percent of the total revenue and be close to 60 percent of the tax return from all the real property devoted to industry, homes, commerce, offices, professions, and other cultural phases of civic life. This result could be summarized as follows:

1. Loss of sales tax would be felt immediately.
2. Loss would be felt gradually as requests for relief are heard and investments reduced on (a) land and buildings; (b) reduced inventories; (c) disposal of capital assets of distressed businesses; (d) parking revenues; (e) business licenses.
3. The trend would become chronic as properties deteriorate.
4. The relative costs of police and fire protection, municipal maintenance and lighting, would increase as the tax base decreases.

What Can Be Done About It?

The problems of preserving the central cores of cities are integrated so closely that it is difficult to isolate any particular problem to the exclusion of others. Obviously, there is a definite relationship of

transportation – public or private – and terminal facilities to the whole problem of downtown renewal or rehabilitation.

The big question naturally asked next is, "What can be done about it?" Numerous suggestions have been offered, all the way from "destroy the old and build new" to "painting the sidewalks fire-engine red and increasing the lighting candle power by 500 percent, with the promotion of 'dollar' or 'gimmick' days." In between such extremes of unrealistic arrogance and inadequate timidity, there can be a constructive middle ground of realism, vision, and understanding within which a pattern for objective renewal of the central core can be formulated.

Mr. Edgardo Contini[1] has some significant ideas on this subject: "We must not think of 'saving' downtown. This is a defeatist term. We must dedicate our effort to the returning of downtown to the vigor, dominance, prestige and splendor to which it is entitled by historical heritage and by geographical location. We must think big, because in this country timidity will never succeed."

Mr. Contini says in regard to traffic: "Traffic is more a symptom than a disease. It reflects an entirely new pattern of living; and, as a high fever, it indicates a deep-seated reaction of the urban framework to such changed pattern. You may lower the fever by aspirin and reduce congestion by one-way streets and synchronized signalization, but neither will cure the disease, which must be understood and attacked more comprehensively. Quite often remedial traffic measures have the habit of creating as many new problems as they solve existing ones."

Formulating a Master Plan

With all the complexities of traffic direction and control, and the accompanying need for terminal facilities, there is also the modernization of buildings and facilities to keep in mind, along with the problem of heavier individual and group promotion and advertising for the whole district to compete with the perimeter shopping centers. To attack the problem of planning without considering these matters in formulating a master plan, would be of little avail except as a temporary expedient.

1. Partner of Victor Gruen and Associates, architects and planners.

It would seem, then, that this master plan must be tied in with an over-all program for the entire metropolitan area. It must be related to the transition from a pattern of uncontrolled mushroom growth and emergency zoning to one of orderly growth along the guidelines of a long-range land use plan, and with the re-appraisal and transformation of much of its present-day strip development and speculative growth stemming from a desire to make quick profits. The plan must be a region-wide system of well-integrated neighborhoods with defined and properly related areas for residential, industrial, commercial and recreational activities.

In the final analysis, the master plan must not only contemplate the relationship of transportation and terminal facilities to the renewal of an already existing area, but must integrate all of these into an over-all co-ordination within the sphere of its trade and cultural influences. Given the support of the people who understand the objectives, and in spite of physical and emotional difficulties, a master plan completely relating all factors can bring order to the future growth of the colossus and correct the mistakes of the past.

To bring well-being and stability to the downtown core, the plan must solve traffic and parking problems and be fully alert to the potential for total renovation of obsolete buildings and districts. It must contemplate the creation of a modern and enjoyable cultural environment. It must be regional in scope; it must be both wise and daring, consistent and long-range. Because only then can it justify community support and rise above local conflicts, narrow interests, and individual selfish greed.

To summarize, if an existing retail area is to maintain its high-level position of providing taxes and an anchor for the city's existence, property owners must realize that to retain the value of their buildings and induce tenants to come, to stay, or both, integration into a master plan is essential. Since the retail area is the basis for attracting so many types of business and professions, the commercial urban economy must be predicated on accessibility for many people who must first become pedestrians and then shoppers.

Adequate parking for automobiles and an improved public transportation system become the keystones of future stability for the entire city. Only with a master planning outlook for the future

can the upgrading of property be secured. It is incumbent, therefore, on any metropolitan area – in self-interest and the protection of its citizens, its industrial, its cultural and its economic life – to bestir itself without delay in solving the problem that must be solved to prevent great areas of our communities from becoming commercial and economic graveyards and eventually ghost urban districts.

The cure for dangerous conditions in the human body requires diagnosis, treatment and surgery. This same technique must be applied to our cities. Without prompt attention to these problems, many of our downtown areas face complete bankruptcy.

South Carolina's New Speed Law

CLAUDE R. MCMILLAN

Mr. McMillan became Chief Commissioner of the South Carolina Highway Department in July, 1947. As executive director, he is responsible for administering all engineering, construction, maintenance and law enforcement functions for the department's 25,000 miles of roads and bridges in the state highway system. Mr. McMillan, a Civil Engineer, joined the South Carolina State Highway Department in 1923 as a junior engineer and served as maintenance engineer, construction engineer, assistant district engineer, district engineer, and in 1941 was promoted to state highway engineer. He is first vice president of the American Association of State Highway Officials and past president of the Southeastern Association of State Highway Officials. He is a member of the South Carolina Society of Engineers and was recently awarded an honorary Doctor of Engineering degree by Clemson College.

SOUTH CAROLINA'S Minimum Speed Law was enacted in March 1956. Strict enforcement of the law, however, began in June 1957 after fifteen months of engineering preparation and education designed to acquaint the public thoroughly with the law. At the end of this preparatory period, hundreds of minimum speed signs had been placed upon 2,700 miles of South Carolina's rural primary highways. Posted directly below the maximum speed limit signs on the same posts, they read "Minimum 40" or "Minimum 35," depending upon the road.

South Carolina's maximum speed limit is prima facie, rather than absolute. Enacted in 1949, as part of the uniform code adopted by the state that year, the law provides that maximum speeds of 55 mph in open country, 35 mph in residential areas and 25 mph in business areas are valid so long as no special hazards exist. Both maximum and minimum speed limits now established in this state provide that "safe operation of a vehicle" takes precedence over any set limit.

Background of Law

The 1956 minimum speed law was not the first of its kind in South Carolina. As part of the uniform code adopted in 1949, the following minimum speed regulation became state law:

"No person shall drive a motor vehicle at such a slow speed as to impede or block the normal and reasonable movement of traffic except when reduced speed is necessary for safe operation or in compliance with law. Police officers may enforce this provision by directions to drivers and in the event of apparent willful disobedience to this provision and refusal to comply with the direction of an officer in accordance herewith, the continued slow operation by a driver shall be a misdemeanor."

Under this regulation, highway patrolmen could only warn first offenders; therefore the provision was largely unenforceable.

However, as more cars, trucks, and buses began to crowd our highways, the slow driver who would not keep pace with the traffic around him became increasingly harassing to the average motorist. And, as the average motorist grew more and more annoyed with "the Sunday driver," he complained to his state lawmakers. With enough of the public aroused, the General Assembly enacted the following law, signed by the Governor on March 2, 1956:

"No person shall drive a motor vehicle at such a slow speed as to impede or block the normal and reasonable movement of traffic, except when reduced speed is necessary for safe operation or in compliance with law. Whenever the state highway department determines on the basis of an engineering and traffic investigation that slow speeds on any part of a state highway consistently impede the normal and reasonable movement of traffic, the department may determine and declare a minimum speed limit below which no person shall drive a vehicle, except when necessary for safe operation or in compliance with law, when appropriate signs giving notice thereof are erected along the part of the highway for which a minimum speed limit is established."

With this law giving specific authority to erect minimum speed signs based on engineering and traffic studies, the department was ready to prepare for enforcement. The operator driving so slowly as to create a traffic hazard was now clearly designated as a traffic-law violator, subject to maximum penalties of $100 fine or thirty days' imprisonment.

Preparing for Enforcement

Three tasks had to be accomplished before the department could begin enforcing the new law. The signs had to be manufactured, routes upon which the signs would be placed had to be selected,

and the signs themselves had to be posted on the highways. It was determined that a forty-mile-per-hour minimum should be posted in the lower eastern half of the state where the terrain is mostly rolling or flat – with a further proviso that signs would be used only where the highways were originally built to sufficiently high standards and were in such good condition as to make enforcement of the minimum speed advisable.

A thirty-five-mile-per-hour minimum would be placed on heavily traveled primary highways through hilly or mountainous terrain. When the terrain was too rugged or mountainous for a safe minimum speed, none was posted. Each highway had to be considered individually. Factors in determining minimum speed were the annual daily average traffic flow, the amount of through-traffic on a particular section of the route, condition of the highway, and speed studies made throughout the state.

Traffic Flow:

The 24-hour annual average traffic flow over the selected routes averaged at least 1,000 vehicles daily. Of course, a route having 2,000 vehicles on a year-round daily average at one section may have carried only 900 a few miles down the road. Therefore it was decided that if a route carried more than 1,000 vehicles a day on a major portion and met the other specifications, it should be posted with minimum speed signs.

For instance, on U. S. Highway 378, between the Savannah River – the eastern border of South Carolina – and Columbia, the state's capital, the 24-hour annual average travel ranges from 850 near the town of Saluda at the center of the posted section of U. S. 378, to 2,800 as it nears the outskirts of Columbia. The department believed that if all other conditions were conducive to a minimum speed, the traffic volume over this route would warrant it.

Speed Studies:

A statewide speed study in July, 1956 was conducted periodically at twenty stations to determine normal speed distributions, average speeds and speed trends on rural highways in South Carolina. An Electromatic Radar Speed Meter recorded speeds

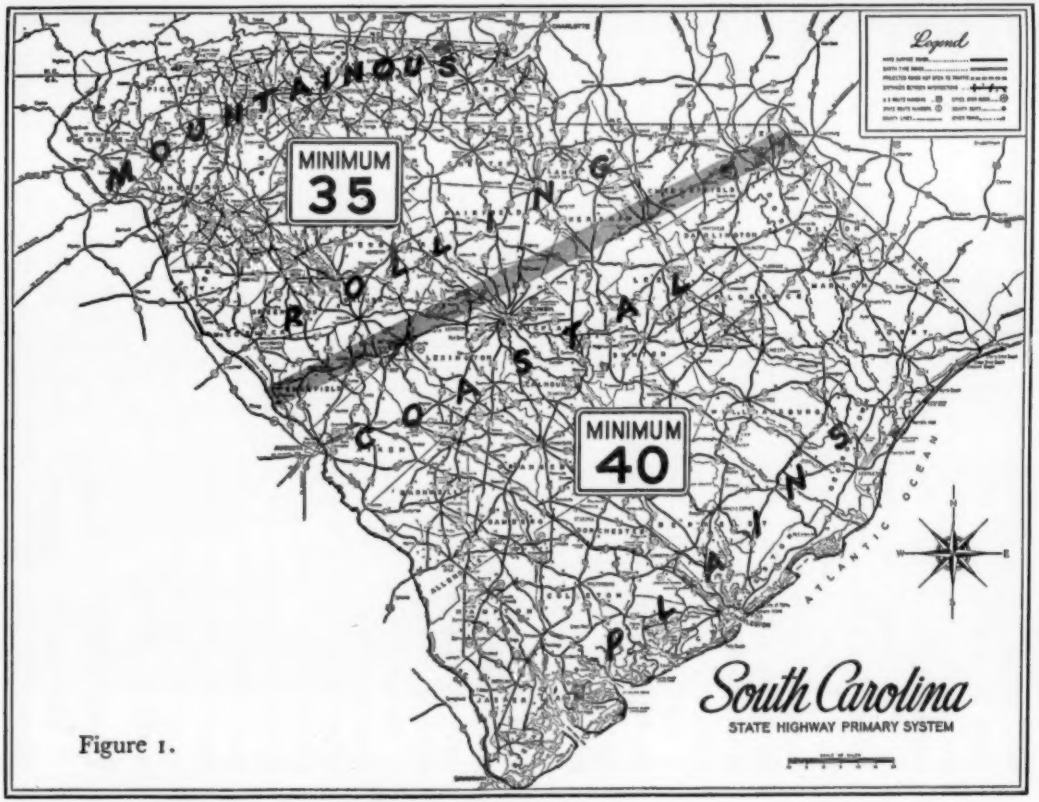

Legend
MOUNTAINOUS
MINIMUM
35
ROLLING
COASTAL
MINIMUM
40
PLAINS
ATLANTIC OCEAN
South Carolina
STATE HIGHWAY PRIMARY SYSTEM

Figure 1.

at each station for four hours, or until a sample of 200 vehicles was obtained, whichever occurred first.

Data were obtained only for vehicles that were freely moving and unaffected by other traffic or highway restrictions. Speeds were not recorded for vehicles accelerating or decelerating near the check zone, nor for vehicles following closely, nor passing another near the check zone.

This speed study was one of the factors in selecting routes warranting minimum speed signs. At one of the check stations on U. S. Route 78, in Dorchester County, 96.7 percent of the cars, 90 percent of the trucks, and all buses passing, traveled more than thirty-five miles an hour. Ninety-one percent of the cars, 80 percent of the trucks and 100 percent of the buses traveled more than forty miles an hour.

Of the total percentage of all vehicles sampled, 87 percent on the highway at that particular point already traveled at a speed above forty miles an hour. By establishing a forty-mile-an-hour minimum limit, only 13 percent of the vehicles would be affected. On other roads, the percentage of vehicles traveling under forty miles an hour was much smaller. For example, on U. S. Route 301 in Florence County, 96 percent of the vehicles traveled more than forty miles an hour and all were traveling more than thirty-five miles an hour.

In the northwestern section of the state, with thirty-five mile speed minimums, even fewer vehicles would be affected. In Greenville County on U. S. Route 25, 98.7 percent of automobiles already traveled more than thirty-five miles an hour. Eighty-five and seven-tenths percent of the trucks using this particular section of road were exceeding thirty-five, and 100 percent of all buses traveled above that speed. The total percentage for all vehicles using the highway was 96 percent, indicating that only four percent would be affected by the minimum speed.

Through-Traffic:

The volume and speed of through-traffic on the highways selected for minimum speed signs were other factors to consider. Our speed studies show that out-of-state cars travel faster than local vehicles. Of the 1,093 out-of-state vehicles observed during the 1956 studies, 98.4 percent were traveling more than forty miles

S.C. State Highway Department photo.

Figure 2. Slow drivers, who consistently block normal traffic flow, are the ones at whom the minimum speed law is directed.

S.C. State Highway Department photo.

Figure 3. South Carolina's minimum speed sign is below the maximum speed sign, on the same post.

an hour. Hence, only 1.6 percent of the through-traffic would be affected by a forty-mile minimum speed sign.

Road Condition:

After speed studies, traffic flow, and through-traffic were taken into account, the condition of the highway was important. The type of road, its engineering features, the terrain, all had affected the overall picture in determining the minimum for any certain route. A notable exception to the thirty-five mile minimum was made on U. S. Route 29. The section from the North Carolina line westerly by Spartanburg was improved to high standards only a few years ago. Now, with new construction underway as part of the interstate system, additional lanes and control of access will enable this particular road to carry the higher minimum speed signs of forty miles an hour.

Minimum Speed Signs

The minimum speed sign was designed to be used in conjunction with the maximum speed sign to eliminate the necessity of replacing existing signs. Rectangular in shape, it has a white background with black legend and is reflectorized. Approximately seven months after the minimum speed law was enacted, the state highway engineer announced that the minimum speed signs had been designed, routes had been chosen and signs were to be erected. The memorandum directed each district engineer to see that these signs were properly placed on the routes marked for his area.

The signs were to be placed in rural areas only where the maximum (prima facie) speed limit of fifty-five miles an hour was already displayed, posted directly below the maximum speed signs and on the same post (Figure 3). Engineers were cautioned not to place a minimum speed sign on a route under construction and to remove the sign when such a highway undergoes future construction until the work has been completed.

Enforcement of the Law

Until the minimum speed signs had been placed on the highways, patrolmen limited enforcement primarily to issuing warnings to

slow drivers. In May of this year, the patrol reported 137 warnings to motorists driving below the speed limit and only two arrests actually made for this offense.

The reason for the delay was two-fold. First, the department believed it would be better to give drivers time to get accustomed to the new law, and to obeying the posted sign. Next, the department preferred to wait until signs were posted on all selected highways, then start strict enforcement of the law in all sections of the state at once. On June 26 of this year, patrol lieutenants were advised that all signs had been posted, and to start immediate enforcement of the law by having their men write tickets for this offense. The public was notified, through newspaper articles and radio programs, that the law would now be strictly enforced.

From the limited experience of patrolmen who have already made arrests for violating the minimum speeds, three types of drivers are found to be violators. The first are the relatively few illiterate or semi-illiterate drivers who do not understand what the word "minimum" means and therefore do not understand the sign.

Educating these drivers as to the meaning of the new sign, as well as some others, creates a difficult problem. Since South Caroline does not have a driver re-examination law at this time, those already licensed to drive cannot be reached by periodic re-testing. Those seeking driver's licenses for the first time, however, will learn about the minimum speed sign. It is shown and explained in our Driver's Handbook.

Another type is the aged person who, not trusting his eyes or his co-ordination, believes that driving at a slow rate is the only safe way for him.

The third type – the one most persons think of in connection with the minimum speed law – is the driver going nowhere in particular, who is sight-seeing, or just out for a ride. Often he becomes engrossed in the scenery and ambles along at twenty or twenty-five miles an hour. He is usually oblivious or indifferent to the traffic piling up behind him and to the frayed tempers accumulating at the same rate as the cars. Often called the "Sunday driver" because he is most frequently seen on that day, he is certainly the slow driver who arouses public indignation and the one to whom citizens referred when complaining of the need for a minimum speed law.

As soon as the minimum speed law was passed, the department began acquainting the public with its provisions through newspaper articles, radio and television programs throughout the state. That the public wanted the law was evident from editorials which appeared in practically all newspapers in the state.

Public Acceptance

From the western part of the state came an editorial view in the *Anderson Daily Mail:*

"Anderson motorists who wish to drive along at a snail's pace must do their riding on country roads and the less traveled highways in the future.

"This week the state highway department began posting minimum speed limits on some of the more traveled roads and highways.

"It is foolish, of course, to contend that slow driving is as dangerous as speeding on highways. No average driver is likely to lose control of a car traveling twenty or twenty-five miles an hour, just as it would be almost impossible to overturn a car at that speed.

"But slow-moving vehicles do sometimes cause other drivers to take unnecessary chances and cause wrecks in that manner.

"The fact is that the slow driver on busy highways is more of a nuisance than actually dangerous.

"In any event, a too-slow driver is out of place in modern traffic, and the highway department is performing a service in eliminating him while they are also keeping speeders under control."

The Greenville Piedmont, the afternoon newspaper of Greenville in the northern part of the state, carried this editorial comment:

"On some South Carolina highways, the highway department has moved to do something about slow drivers, often as great a menace as speeders. Under many of the signs which state the legal speed limits for cars and trucks the highway commission has erected oblong signs which read 'Minimum, 40.' This is an important forward step toward regulating traffic on highways and preventing accidents."

From Charleston, South Carolina's seaport town, comes this editorial comment from the *News and Courier*, one of the state's largest newspapers:

"The State Highway Patrol has a new problem: How to enforce South Carolina's minimum speed law.

"It will have to decide how to keep traffic moving without unjustly penalizing motorists who take it easy for safety's sake.

"One target for the Patrol under the new law will be the Sunday Driver.

"The Sunday Driver (seen on other days, too) takes his own sweet time. He lets traffic pile up behind him until somebody down the line takes a chance on pulling out and passing.

"The Sunday Driver seldom gets into wrecks, but he's a danger just the same.

"The minimum speed law will be a success if the Highway Patrol can use it as a prod for the Sunday Driver."

Among many editorial comments, none against the minimum speed law has come to the department's attention.

It is still too early to tell exactly what effect on our accident, injury and death rate, if any, this law will have. We believe it is definitely a step toward safer highways and more efficient movement of traffic.

The slow driver must learn to keep pace with modern day traffic. He must either join the normal flow of traffic and learn to share the road with his fellow motorists or he must take the consequences – a traffic ticket.

Driver Testing and Training

DONALD S. BUCK

Mr. Buck is Safety Director of the Army Transportation Corps and a staff safety specialist in transportation for the Department of the Army. Previously he had served for three years as an Indiana State Trooper and for eight years on the staff of the Army Safety Director. He designed the Porto-Clinic psychophysical test device and has both written and lectured on traffic safety. He is a member of the American Society of Safety Engineers and Chairman of the Motor Vehicle and Traffic Division of the Federal Safety Council.

A DOG LICENSE is issued for any dog upon the payment of a fee. It bestows the privilege to own a dog. It is required for both a trained dog and a mongrel, but it offers no guaranty of either dog's performance. No one expects equal performance from trained and untrained dogs merely because they display similar licenses on their collars.

Yet we tend to expect competent and responsible performance from our licensed but inadequately trained – often indifferent – drivers, as from those whose instruction, experience, and attitude are of high – at least safe – stature.

Is it not time to examine our licensing and training procedures? Every year we *license* some 6,000,000 persons to drive. And annually they join with other licensed drivers to produce millions of accidents, with more than a million injuries, more than 100,000 permanent disabilities, and some 40,000 deaths. The economic losses are huge, exceeding $5 billion a year – partly reflected by the hundred dollars or so which each driver annually pays on his insurance policy – a method for paying for our next accident on the *installment* plan: so much down and so much annually as long as you drive.

It is unusual to find drivers, in any adult group, who have never been involved in an accident of any sort while riding in or driving a motor vehicle. Most of us licensed for five years or more have experienced an accident. Probably most of us whose accident-records remain clear are mathematically overdue.

What comprises the usual licensing procedure? And what is wrong with it?

To a large extent, driver-licensing entails various measurements of personal factors – some of which are known to possess little or no relationship to predicting driving performance, some of which are more useful from a training standpoint.

The drivers' test program usually includes measurements of:

1. Physical ability
2. Mental ability
3. Knowledge of traffic law and driving technique, principles
4. Driving skill
5. Means of identification – and registry

There is wide variety in the standards, the test apparatus, and the requirements.

No driver-test has been developed that perfectly separates "good" drivers from "bad." Belatedly, we are learning that, at times, drivers generally good can become "bad," when motivated by hurry, worry, sleeplessness, irritation, distraction, illness, or romance. It is common knowledge that some husbands, ordinarily law-abiding drivers, undergo a temporary change in the anxious dash to a hospital.

Experience as a state trooper, in which many excuses were offered by those involved in accidents or offenses, convinces me that the element of "hurry" deserves more attention in our test procedures. We probably would find a significant correlation between accident-free driving and departures timed to provide reasonable driving time for any given trip! Conversely I suspect that the practice of belated departure, whether the trip is one mile or one thousand, tends to necessitate hurry – which leads to excessive speed, fatigue, worry, impatience, preoccupation, and unnecessary chance-taking.

Driver Tests Are Not Realistic

Recently, at a youth safety forum, newly licensed teenagers agreed that drivers' tests are too easy! Youngsters said the road test seemed specially subject to criticism. "They took me around the block at twenty miles an hour," one lad complained, "and licensed me to drive at 55!" Others pointed out that road tests are suspended in the event of darkness, snow or ice – although circumstances later may require driving under these conditions. Congested traffic areas

were carefully avoided. One young man suggested "the only way to find whether we can drive under adverse conditions is to try it."

The informational part of most road tests deals principally with "the law" rather than with techniques of driving. Questions of the distance from a fireplug in parking, speed limits, and traffic regulations are commonplace. Test areas infrequently include measurement of one's knowing how to return safely to the pavement after leaving it; the effect of locked brakes on steering, or the best way to check and signal to traffic before changing lanes, direction, or speed. We give greater attention to the problem of parking within six inches of the curb than to safe procedure for entering traffic from that position.

This lack of realism in testing characterizes most of our psychophysical testing procedures, too. Usually we place our candidate in front of apparatus, alert him to watch for a red light, or other stimuli. Subsequently we obtain from him a measure of his ability to respond when he is expecting the problem. This response may not characterize his performance in an actual driving situation.

A few years ago in a midwestern state, an enterprising young man concerned with traffic safety and driver testing strongly questioned the validity of the conventional testing procedures whereby driver licenses are issued. He reasoned that test-findings derived from apparatus or pencil-and-paper tests may not be truly representative of the individual's response to an emergency situation while actually driving. So he evolved a test – to supplant all tests – one that would predict the performance of the unsuspecting examinee. It proved successful beyond his wildest dreams.

His plan appeared simple and fool-proof. An open stretch of four-lane highway was selected – wide level shoulders, with neither physical hazards nor distractions. A large semi-outfit was properly parked off the road, on the shoulder, with three red flags flapping their warnings in the positions prescribed by law. To the passer-by that was the scene – simply a parked semi-tractor rig, off the pavement, the usual red flags, with nothing to be seen.

What the passer-by couldn't see was carefully hidden in front of the tractor: an inclined plank so arranged that it would permit a boy-sized, life-like, straw-filled dummy poised on roller skates to roll briskly down the plank at four miles an hour directly into the path of any passing vehicle. To insure accuracy and fairness

the dummy was released by mechanism controlled by an electric eye-beam across the road and 190 feet to the rear. A vehicle interrupting the light beam would immediately be confronted by the dummy that would dart into the road, precipitating a valid test.

The findings seemed conclusive. Clearly proved was the suspicion that the average driver possesses little more than the legal permission to drive, as established by unrealistic tests given on apparatus or with pencil and paper.

What happened? One hundred and thirteen drivers were subjected to the test, before their mass indignation caused its termination. Eight out of ten dramatically failed the test – by colliding with the dummy, by swerving off the road into the fields on one side or the other, or by swerving and hitting the parked truck. Few expressed appreciation. Especially stubborn die-hards insisted on a second trial at the same speed as their first. Without exception – alerted, expectant and determined they passed the repeat examination with a healthy margin to spare. Unfortunately, second chances are not offered in actual accident situations. This test obviously possessed disadvantages: vehicles wrecked or stuck in adjacent fields, or drivers so frightened and indignant that temporarily they were in no condition to continue driving, even if their vehicle survived the test.

Driver Test Findings Are Not Applied

The time when an individual is most susceptible to suggestion and correction to improve his driving is during his test. It seems ironic that little information regarding specific driving failures is given the applicant following the test. The test is more often an effort to gain an understanding of the individual – his background, performance, ability, and personality – than to help him to gain a better understanding of himself! While I know my *score* was adequate on the road test and written test, I do not know what mistakes or adverse traits characterized my performance. While those mistakes may have been few, nonetheless they were important – ones that might result in an accident.

Testing agencies are concerned with maintaining a high degree of reliability on their tests. Hence they are generally reluctant to reveal test items to applicants lest they convey this information to

others, who would have an opportunity to prepare. Item-*values* should not become common knowledge; yet the disinclination to let the public know what areas are included in the testing procedures denies the opportunity to improve every driver by pointing to specific weaknesses and poor performance. Surely, those who most effectively employ driver-tests use them as sounding boards not only of aptitudes, but primarily as indices of training needs. If drivers in obtaining a license become aware of their weaknesses, and are shown how to overcome them, the test becomes also a driver-improvement.

Some Tests Have Inadequate Validation

Claims for the value of widely accepted tests are based on results with relatively few drivers. Validation of some tests rests on the correlation between test-scores and employers' ratings on twelve drivers.[1] This early study was a British effort; yet more recent research in the United States was validated on only thirty-five cases[2] while 150 to 200 cases seems the rule rather than the exception.

Aptitude tests for army motor vehicle operators were validated from three experimental runs by more than 1400 men. Nearly 1100 cases were selected on the basis of sufficient driving experience and adequate ratings.[3] This is not intended to suggest that we should *wait* until every promising tool has been validated; rather application of new ideas should be encouraged on all sides to find more effective ways to prevent accidents. However, we should recognize these methods as merely "promising tools" until validated in meaningful samples with accurate statistical methods.

Lack of Standardization in Licensing Procedures

Not only are there tests that suffer for lack of validation; some apparently effective procedures are carefully avoided or discarded because validation has not been attempted or accomplished.

1. Vernon, H. M. *Accidents and Their Prevention.* The Macmillan Co., N. Y., 1936.
2. Johnson, H. M. *Detection and Treatment of Accident-Prone Drivers.* Psychol. Bull. 43 C67: 489–532, 1946.
3. PRS Report 981, *Aptitude Tests for Army Motor Vehicle Operators.* A. H. Lauer, Iowa State College, Ames, Iowa.

The incredible deviation by various states from recommended standards for driver licensing is common knowledge. It is a source of irritation to drivers everywhere. It inconveniences the individual. It imposes needless administrative burdens on the states. Act II of the Uniform Vehicle Code, the *Uniform Motor Vehicle Operators' and Chauffeurs' Licensing Act* is the model for driver licensing. It is the closest thing to an average of all state laws, because so many are patterned on it. It conforms to recommendations of the President's Highway Safety Conference. It does not mean it is the best possible model in all ways.

Even if they had exactly the same law, two states might well handle drivers with bad records differently. For example, one state might have very little money to work with and therefore could handle only the most serious and conspicuous cases. Also, some driver-license divisions, often very gradually, have gained the firm confidence of the public and courts for their sincere interest in safety and their fair and helpful treatment of drivers. These states can act more energetically without danger of unfavorable reactions than other states in which the driver-improvement program is less firmly rooted.

The driver-improvement program of states with similar laws may differ in other ways, too. One state may have a policy of dealing severely with a small number of offenders. Another may believe it more important to give attention to a large number of violators than to bear down on a few. These two policies are sometimes spoken of as "hard" and "soft," although such words do not describe them well.

We cannot yet fairly evaluate the results. The state will have done its main job if it seeks to do more in improving drivers with the money it has to spend on this work; if it shows how more can well be spent for driver-improvement, and perhaps most important, if it speeds the time when driver-improvement in licensing is better understood and more fully supported.

The minimum age for an operator in Nebraska is sixteen years. New York, Pennsylvania, and Vermont consider eighteen years essential before the public hands car keys over to a youngster. If your Nebraskan youth lived in South Carolina or New Mexico, he would possess sufficient maturity to be licensed at fourteen. Our forty-eight states are *not* united in driver-licensing procedures.

Variations apply to cost of license, ranging from $5 (good for two years) in Massachusetts down to fifty cents in Virginia and South Carolina for three years. Licenses have a duration of from one to five years in various states – and are valid indefinitely in Maryland and Hawaii. Some states disqualify persons with a bad behavior record; others realize this could interfere with one's livelihood and use no standard.

Examination on signs, laws, and driving is pretty general. Visual acuity standards seem to range from twenty-twenty, two eyes with glasses, in Maryland, Massachusetts, Ohio and Virginia, to twenty-forty, two eyes with glasses, in Arizona, Connecticut, and some eleven other states who prefer that you see what you're going to hit a little sooner. Depth perception tests are given in ten states, color blindness not tested in twelve. At least two states – Iowa and Mississippi – are concerned whether the driver can see after dark, while fifteen examine the visual field. A dozen states have no hearing test. Actual re-examination for renewal is standard practice and required by four states, with Colorado, Iowa and North Carolina leading the list.

Re-examination *may* follow conviction for negligence in most states, but at least thirteen make this a *must*, and twenty-three require re-examination for renewal after suspension or revocation. Re-examination is *not required* for renewal of license for physical or mental handicap in twelve states. Finally, Iowa, Maine, New Hampshire and Virginia are among the few that suspect that advanced age warrants re-examination.

In any event, there's room for improvement in licensing procedures.

Why Test?

Driver selection by means of some effective test, capable of accurately measuring characteristics that reflect the likelihood of accidents, has long been the hope for accident prevention. Unfortunately, tests tend to measure *general ability* to perform satisfactorily; they fail as predictors of *individual* performance. They cannot compensate for later development of occasional intoxication, carelessness, illness, anxiety or for irritation resulting from an argument.

The concept that a small percentage of the driving public experiences most of the accidents – and the theory of accident

proneness by a few – also strengthen the demand for a driver-test designed to exclude everyone else "except me, of course, and my kind."

We must not lose sight that much good can be done through effective driver-licensing methods. At best, licensing is based on an estimate of the chance of future accidents. Each of us is a calculated risk. We are members of the survivor's group. In its simplest terms, the *giving* of a license is predicated on the premise (based on test findings) that the driver will perform satisfactorily. Similarly the license is withdrawn (suspended or revoked) when performance (accident, violation or other adverse performance) or ability (fitness, health, advanced age, or mental condition) proves unsatisfactory for proper operation of a motor vehicle.

Among the reasons for testing are these:

1. To identify good drivers
2. To obtain information for driver-improvement
3. To identify and bar incompetents
4. To obtain an understanding of the aptitudes and abilities of all drivers
5. To re-examine those whose driving performance warrants it
6. To prevent accidents

Both drivers and dogs are licensed to operate – a fee or tax imposed in each case. Little is required of the dog – except he be a dog. I regret that in too many cases, little is required of the driver, except that he be a driver. Demonstration of performance under realistic conditions of driving is rare, if existent. But all is not hopeless. In dogs – and drivers – *breeding* plus *training* are essential to obtain top performance. We can do little about the backgrounds of dogs and drivers – but when it comes to training – well, here is the challenge.

Training

If a driver is among the few who are "mongrel" to our highways, he may lack the basic traits, the sense of social responsibility, the perceptiveness, the moral character, the mental ability, the motor ability, the health, stability, or fitness essential for driving. These may not respond to training – and our driver will best be barred from driving on the highways.

We know that accidents usually result from unsafe driving acts

(most are violations of law) and may be identified as bad practices. We believe they result because drivers have wrong attitudes, are poorly informed, or unskilled. There is mounting evidence these may be offset or improved through driver training. Driver training may be accomplished through many means:

1. A traffic ticket can help teach precise meanings of posted speed limits, or other traffic law.

2. Driver education, with behind-the-wheel instruction, can help prepare young people for mature, adult driving.

3. Adult driver education (whether conducted for interested persons through the schools and colleges, or for chronic offenders at violator schools).

4. Driver training in commercial training schools, such as may be conducted by AAA, and Easy Method Schools.

5. Continual emphasis on traffic safety in elementary schools.

6. Organized program of training through the media of magazines, newspapers, radio, TV, and motion pictures.

7. Publicizing roadeo contests, enforcement and safety campaigns, vehicle equipment check-up, special warnings, accident data, etc., to inform and motivate the public.

8. Strengthened license regulations.

Prerequisite of Proper Driving

"The driver must first learn a series of complex co-ordinated tasks involving both hands, both feet, vision, and hearing. This co-ordination must be learned to a point where it becomes semi-automatic before he can hope to operate in traffic with any degree of safety. He must also learn to make judgments of changing space-time relationships. He must operate in close proximity to other vehicles of different sizes and speeds going in the same ways and streets—which requires passing other vehicles with a clearance of one foot to ten or twenty feet, and at various angles. When the time intervals within which he must react, even at relatively low speeds, are considered, it will be seen that he must learn to anticipate conditions and situations.

"If two cars are approaching at 30 mph and one driver loses control when they are 45 feet apart, each driver has 0.5 second to react. This means, in the light of our present knowledge, that he

would have just time to get his foot on the brake, but there would be no possibility of the brake application stopping the cars in time to prevent a collision. Thus the factors of foresight, planning and appreciation of hazards must be involved to a major extent. Actually, it seems probable that more continuous attention from moment to moment is required of the motor vehicle driver than of the operator of any other type of transportation including the airplane."[4]

Dancing Versus Driving

Interrogation of large groups of male audiences indicates that seven times as many adult males were taught by a professional licensed instructor to *dance* as were taught to drive. Dancing lessons will help an individual on a dance floor. Yet we demand validation before risking *half* the expense of a dancing course on a driving course! After all, the majority of us learned to drive, not by being taught at a school, but by hit-or-miss experience (mostly *hit* for a lot of us!) How would we regard the ancient civilizations beset with plagues as recorded in our history books, if we knew they possessed knowledge of how those plagues could have been reduced but failed to apply that knowledge because it would cost time and tax? By comparison with traffic accidents today the worst of the plagues were mild social problems. However, the ancients lacked the knowledge essential to offset plague; significantly, we *know* how to prevent accidents: teach people to *drive*!

Research—Needed

A questionnaire opinion survey prepared by the NEA Research Division for the National Commission on Safety Education, polled a selected group of 2548 persons in the educational field and other related fields for opinions on the relative values of suggested studies. The most critical need indicated was for an *evaluation of driver education programs in the public schools!*

Do trained students have a better record of driving than non-trained drivers? How do police, judges and others who conduct

4. Committee on Highway Safety Research of the National Academy of Sciences National Research Council, *The Field of Highway Safety Research*, Washington, D.C.: The Committee, 1952.

hearings of traffic offenders evaluate driver training? What are the strengths and weaknesses of driver training?

The second critical need was for the development of research to *help identify accident-free versus accident-liable drivers*. What are the characteristics of drivers with continuous records of accident-free performance? What combinations of attitude and skills make a safe driver? Can we predict performance – in a dance? The third general area of research requested was a summary of findings of how attitudes and behavior of individuals respond to training.

The fourth area judged most needed was examination of skill and knowledge tests currently in use, to determine their predictive values.

The fifth research area was identification of effective teaching techniques which *improve* behavior.

In another NEA publication "A Critical Analysis of Driver Education Research, 1957," there are listed four comprehensive reports, summaries, or analyses of research on the effectiveness of driver education:

1. *Driver Education Proves Its Worth*, a report issued in 1955 by the American Automobile Association.

2. *Driver Education in High Schools*, issued in March 1953 by the Institute of Government, University of North Carolina.

3. *Research on the Accident Reduction Value of High School Driver Education*, June 1955, Accident Prevention Department, Association of Casualty and Surety Companies.

4. *Proposed Driver Education Program for Portland Public Schools*, December 1954, Department of Research and Measurements, Portland, Ore., Public Schools.

The results are interesting. The AAA concluded that research proves the accident reduction value of high school education, but more research is necessary in specific areas. The Institute of Government suggested more research although it admitted the face value of existing research appeared convincing.

The Association of Casualty and Surety Companies said that social need was adequate justification for an expanded driver education program. The Portland study also called for more adequate research, suggesting the program be limited to classroom work only.

At least 6,000 high schools offer complete driver training courses

(including behind the wheel practice) to more than 300,000 students annually – at a cost of approximately $30 for each student. While there is a wide variation in the results reported in various studies made, the overall picture suggests that completion of a high school driver course results in substantially better driving records. Improved teaching methods will obtain better results.

In reviewing any training course, the following factors must be examined carefully.

1. Compare like sexes (girls show most improvement)
2. Compare on basis of like mileages
3. Equate interest and attitude (volunteers versus others)
4. Age level
5. Equal education
6. Like driving conditions
7. Quality of instruction

The army administers Battery I to all inductees. We are considering the possibility of developing a driver-improvement clinic, patterned after the New Jersey accident-prevention clinic, but designed to rehabilitate persons with significantly low scores on the Battery I test, to see whether driver-performance can be improved on these persons who, although not qualified to drive Army vehicles, operate their own vehicles upon public roadways.

Training Test

One of the more promising techniques in driver-training is a visual perception training and testing program for experienced drivers – a commentary-driving road test technique in which the examinee is required to "think out loud" while driving. This program was developed by Harold L. Smith, John J. Cummings, and Dr. Reuel Sherman. It features a critique following the test. It measures seeing habits, or visual perceptiveness, normally carried out subconsciously. The Traffic Institute of Northwestern University evaluated this procedure, and reported highly favorable results.[5] If this technique were adopted for every road test, I believe findings would much more closely reflect what the driver actually saw and thought – and remedial training should take on new dimensions of value and effectiveness!

5. *Traffic Digest and Review*, Nov. 1956.

As with testing, driver-training often is not realistic. Young men generally agree that training lacks realism with respect to speeds and conditions which the average motorist will experience.

Frequently I wonder whether the amount of time devoted to various training areas relates to its relative importance or problem in safe driving. Much time may relate to "who has the right of way," with little time spent preparing the student to become accustomed to the operation of a vehicle at normal highway speeds, under conditions of weather, light, fatigue, and rush which may characterize his actual driving. Driver training should not end with the license. It should be a continuous enterprise designed to acquaint the driver with the constantly changing requirements and problems of driving. At least, the properly trained man involved in accident or violation will lack today's honest excuse "I did not know . . . "or "I did not realize . . ." or "I did not expect. . . ."

The high school driver students should be taught to discriminate between *proper* and *improper* driving by other motorists. I'd like to see the youngsters given a chance to note the time, place, and license numbers of other vehicles flagrantly driven in violation or unsafe manner. Permit the youth to address a letter to the owner of the vehicle, suggesting he admonish the driver who was observed to set so poor a driving example for youth to follow. This need not be "recorded against the offender's record" – it is possible that recording it against the conscience may alert the adult to the fact that our poor – or good driving – will be mirrored by our youth.

Urban Roads Given High Capacity Through Medians and Signals

A. L. HIMELHOCH

Mr. Himelhoch is Assistant District Engineer, Traffic Division of the California State Department of Public Works. District VII of the Division of Highways includes some 1400 miles of state highways largely in metropolitan developed areas. Mr. Himelhoch joined the Division of Highways in 1936. He is an associate member of the American Society of Civil Engineers and the Institute of Traffic Engineers, and a member of the American Geophysical Union.

THE rapid industrial growth around the Los Angeles International Airport is generating increased commuter traffic to and from that vicinity. Streets and highways feeding the area are therefore becoming more and more congested.

Since only one major through-highway, U. S. 101 Alternate, leads south from the Airport, extremely heavy peak-traffic volumes increased congestion and delay on this route to the point of making some type of improvement essential. The highway was a four-lane, undivided road, with considerable roadside business throughout. Additional right-of-way expense for widening was not considered economically feasible, particularly in view of freeway development in three or four years.

The plan was to improve the roadway within existing curbs in four ways:

1. Installing additional traffic signal controls to allow cross traffic through the barrier created by heavy traffic flow on U. S. 101A.

2. Converting existing traffic signals to three-way operation because of very heavy left-turn volumes.

3. Supervising all traffic signals within this system by a traffic-controlled variable cycle and preferential master electronic computer to provide maximum traffic-handling ability, automatically adapting to favor the heavier direction.

4. Constructing a curbed median divider throughout the system providing left-turn lanes to reduce accidents and to allow smooth and efficient traffic flow.

The project was completed this year at a cost of $185,400. After testing and adjustments, the results in operation and traffic-handling ability were outstanding. With hourly volumes up to 1500 vehicles a lane and 780 left turns, the system proves that traffic engineering can alleviate many surface street congestion problems previously thought insolvable.

Morning and evening rush-hour traffic congestion on our highways is a persistent and increasing problem in every metropolitan area. The commuter-by-car constantly applies pressure on the traffic engineer to eliminate bottlenecks and delay on the route to and from his place of employment. He is always in a rush to get to work and in a bigger rush to get home.

He is one of a large group of commuters comprising nearly half of the total traffic using many metropolitan area highways on any working day. Driving in peak traffic or on the crest of the wave, he receives the impression that the congestion period is endless, when actually at any given point on his route it will last only for about an hour, morning and evening.

This, of course, is the hour of congestion that we would all like to see eliminated.

Airport Area's Industrial Traffic

In the Greater Los Angeles Metropolitan Area, many arterial highways serving commercial and industrial areas are becoming increasingly congested during the morning and evening peak rush hours. Freeways are being built as rapidly as possible to alleviate these congested surface streets. However, many existing highways require immediate improvement.

The southwestern section of the Los Angeles metropolitan area has grown in the last few years at an unprecedented rate, mainly because of aircraft industrial development around Los Angeles International Airport. Two plants in the area presently employ about 45,000 persons. In addition, an estimated 35,000 passengers a day will use the expanded airport facilities in the near future. Many other plants in the immediate area employ thousands more.

Sepulveda Boulevard, the only major highway leading from the airport area to the beaches south of Los Angeles, is the major north-

south coastal highway along the Pacific Coast, serving coastwise through-traffic. (Figure 1.) In addition, Route 7 merges from the north into U. S. 101A at the airport, feeding traffic from the San Fernando Valley and western sections of Los Angeles.

Figure 1. Vicinity Map.

The peak load of local commuter traffic is therefore superimposed upon the normal coastwise commercial and recreational

Figure 2. Looking north on Sepulveda Boulevard, (U.S. 101A), showing conditions before the improvement.

through-traffic, creating an extremely heavy and prolonged traffic rush hour.

As no through, parallel north-south routes are close enough to be used as alternate routes, this heavy stream of traffic flows south on Sepulveda Boulevard through the residential beach city of Manhattan Beach. Extreme congestion along the route created a barrier to the local beach area cross-traffic that was nearly impassable. The freeway planned to relieve this route will not be completed for several years; hence, an immediate improvement in the area was indicated.

The real problem existed between Rosecrans Avenue on the north to Gould Lane on the south—a distance of two miles. The highway within these limits was undivided, striped for four lanes, seventy-six feet wide from curb to curb, of adequate structural section, and with relatively straight alignment. Vertical alignment introduced an extra problem since most of the major cross streets intersected at the summits of hills. (Figure 2.)

There is considerable roadside business with unrestricted parking. Developed areas east and west of the highway are residential. It was not considered economically feasible to purchase additional right-of-way or to widen the roadway because of high business property costs, particularly in view of near-future freeway development. The improvement, therefore, had to take place within existing curbs.

Three-Year Study Preceded Improvement

To proceed logically with a plan for improving the highway, a complete analysis of the conditions was necessary.

First, Sepulveda Boulevard traffic was a barrier to local vehicle and pedestrian cross-traffic. Second, because of the few major through cross-streets in this area, considerable cross traffic and heavy turning movements occurred at these major intersections. The four major cross-streets intersections – Rosecrans Avenue, Marine Avenue, Manhattan Beach Boulevard, and Gould Lane (Figure 3) – were controlled by existing two-phase full-traffic actuated, volume-density signals. This equipment provided the highest available type of isolated intersection two-phase control. These

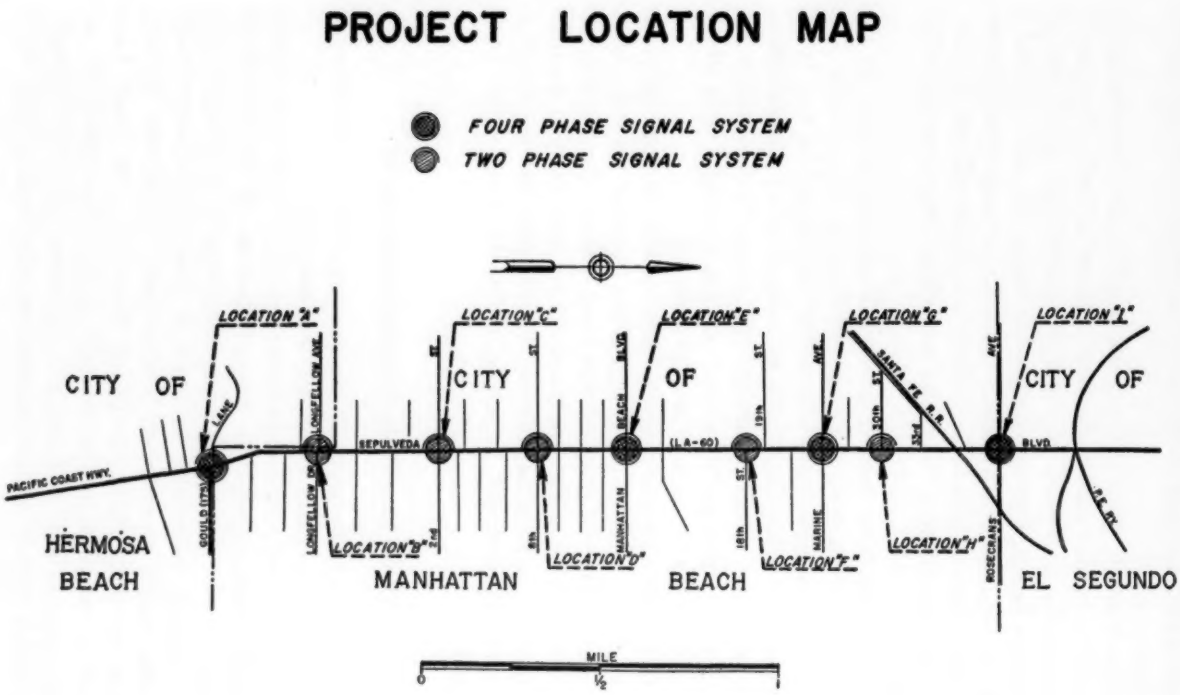


Figure 3. Project Location Map.

signalized intersections were all one-half mile or more apart, and were not co-ordinated to provide any progressive or platooned traffic flow. However, because of heavy left-turn traffic, the traffic-handling ability of these two-phase controls was highly inefficient.

Third, records revealed a high rate of accidents with a predominance of the left-turn type at the major intersections, but with an abnormal number of head-on and rear-end collisions. At the minor intersections, accidents were equally divided between intersecting, rear-end and turning types. The three-year study gave a total of 233 reported accidents – 101 night and 132 day.

Fourth, the traffic flow pattern shown in Figures 4 and 5 is highly directional: extremely heavy northbound in the morning with relatively few left turns; in the evening, largely southbound with heavy left-turn traffic. This pattern is generally the same at all four major intersections.

Analysis of the conditions led to several possible improvement solutions.

1. To relieve the barrier problem, it would be necessary to provide gaps in the traffic flow along Sepulveda Boulevard by co-ordination of existing traffic signals, thus allowing pedestrians and vehicles to cross. Unfortunately, with the half-mile and more spacing between traffic signals, the platoons would spread out, generally resulting in gaps too short to allow sufficient crossing time. To insure a gap of sufficient duration to allow crossing, traffic signals could be installed at intermediate intersections to provide approximately quarter-mile spacing.

2. Heavy left-turn volumes and high turning and rear-end accident rates at the major intersections would only be alleviated by left-turn lane channelization and protective three-phase signalization. Five additional intermediate signals would provide a system of nine signalized intersections all co-ordinated to provide progressive platooning of traffic.

However, a platoon of traffic should be unobstructed in traveling through a signal system. Left-turn lanes were required at every intersection since one car waiting to turn left at an intermediate nonchannelized intersection may hold up one lane of the platoon, reducing operation efficiency by as much as fifty percent. Therefore, a continuous divider providing left-turn lanes for all the cross

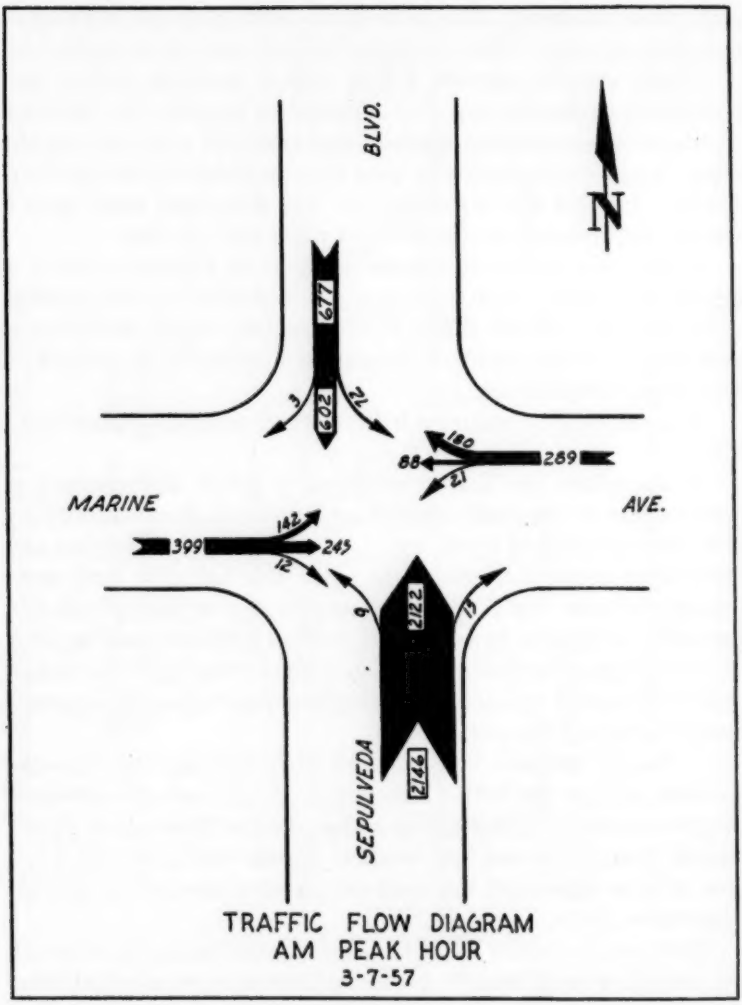


Figure 4. Traffic Flow Diagram During Morning Peak Hour.

streets was essential. This design was also a solution to the head-on accident rate as well as other accident types between and at the minor cross streets.

With a continuous divider, the 76-foot roadway could be developed to provide two 31-foot roadways, each consisting of two 11-foot lanes and nine feet for parking, separated by a 14-foot curbed median. The median furnishes area for a 10-foot left-turn lane of varying length depending upon left-turn volumes.

Selecting the Signal Equipment

The peak hour traffic flow diagrams not only showed the need for some type of left-turn phasing at the major intersections, but also that the Sepulveda traffic volume would require a high percentage of the available green time. This meant that long signal cycles would be needed during the peak hours, but shorter cycles would be sufficient during off-peak periods. Ideally, the cycles and resultant green times should match as nearly as possible the traffic-volume demand. The equipment selected was, therefore, a master traffic computer to detect the traffic volume on Sepulveda Boulevard and select the proper background cycle.

In addition, the flow diagrams showed a definite directional flow, extremely heavy northbound in the morning and southbound in the evening. It was necessary then to provide for directional detection and analysis. To adjust for the directional characteristic of the traffic, a second master traffic computer was selected. The cycle length for the system could then be determined by the computer detecting the heavier directional flow. A difference in directional flow could also be detected and preference given to the direction of heavier flow.

The system thus developed may be called a co-ordinated variable cycle, preferential traffic controlled signal system. It provides continuous automatic supervision of the nine signalized intersections controlled by the vehicular traffic flowing on the highway.

The local intersection signal control selected was of the semi-traffic actuated type, allowing side street green only on pedestrian and vehicular demand. This method provides the maximum amount of green for Sepulveda Boulevard. The five minor inter-

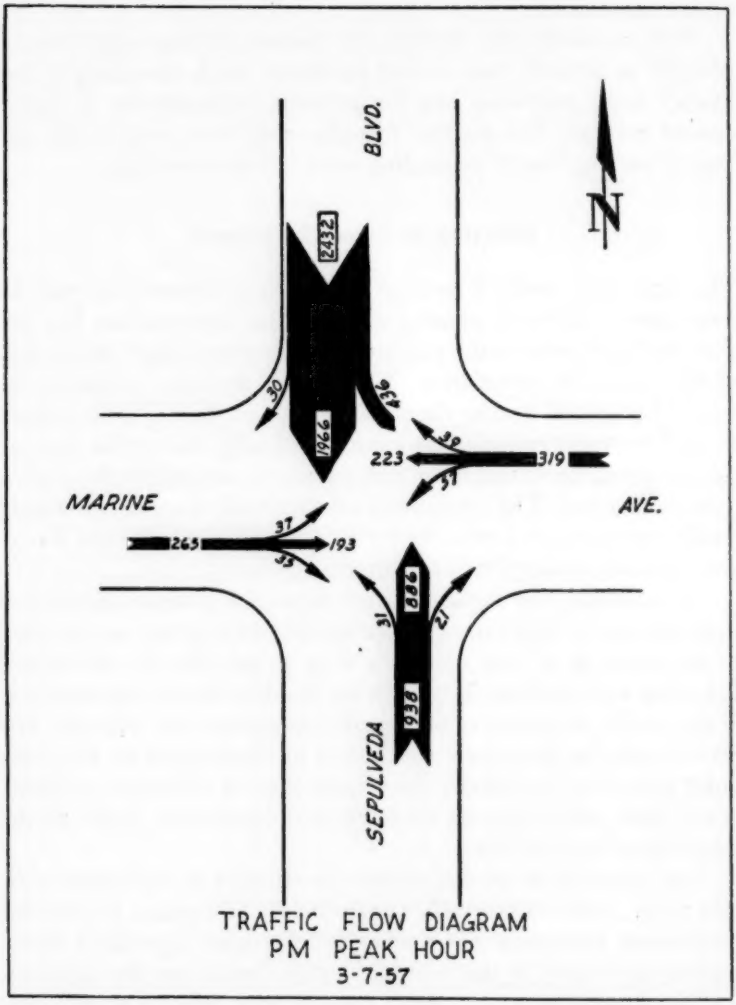


Figure 5. Traffic Flow Diagram during Evening Peak Hour.

sections are two-phase and, as previously mentioned, the four major intersections required an additional phase for the left-turn movement.

The usual type of phasing when the left turn is given separate phasing might be A-phase for the through-movement on the main artery, B-phase for both left-turn lanes, and C-phase for the cross street movement. Inspection of the typical flow diagrams will show that due to a fairly well balanced opposing left-turn volume during the morning peak hour, this type of phasing would be satisfactory.

However, the evening peak hour flow diagram shows extremely unbalanced opposing left-turn volumes – a condition that would produce poor operating results were this type of phasing to be used. Therefore the more standard phasing was abandoned.

As noted, all four major intersections show similar traffic patterns which should remain fairly constant in the future because of the topography. The narrow strip of developed land between Sepulveda Boulevard and the Pacific Ocean is principally residential and incapable of generating a large traffic volume.

Signal Phasing Proved Efficient

The phasing shown in Figure 6 was therefore developed. It provides an overlapping green for the heavy southbound evening through-movement during the heavy B-phase left-turn movement. This is a convenient traffic pattern in that the maximum amount of green time is used. During the morning peak hours, B-phase traffic is light and southbound traffic is also light, so the additional green provided by the overlap is not needed. As B-phase green time will be short because of light traffic-demand, unused available green will be automatically added to the unactuated A-phase green time. This additional green for A-phase is greedily used up by the morning heavy northbound through-traffic.

It may be noted that the phase diagram actually shows four movements. With the A, B, and C phasing as shown, something had to be done about the northbound to west left-turn movement. Although it is a consistently light movement, a protected left-turn phase was considered necessary because of extremely heavy opposing southbound through-movement in the afternoon peak period.

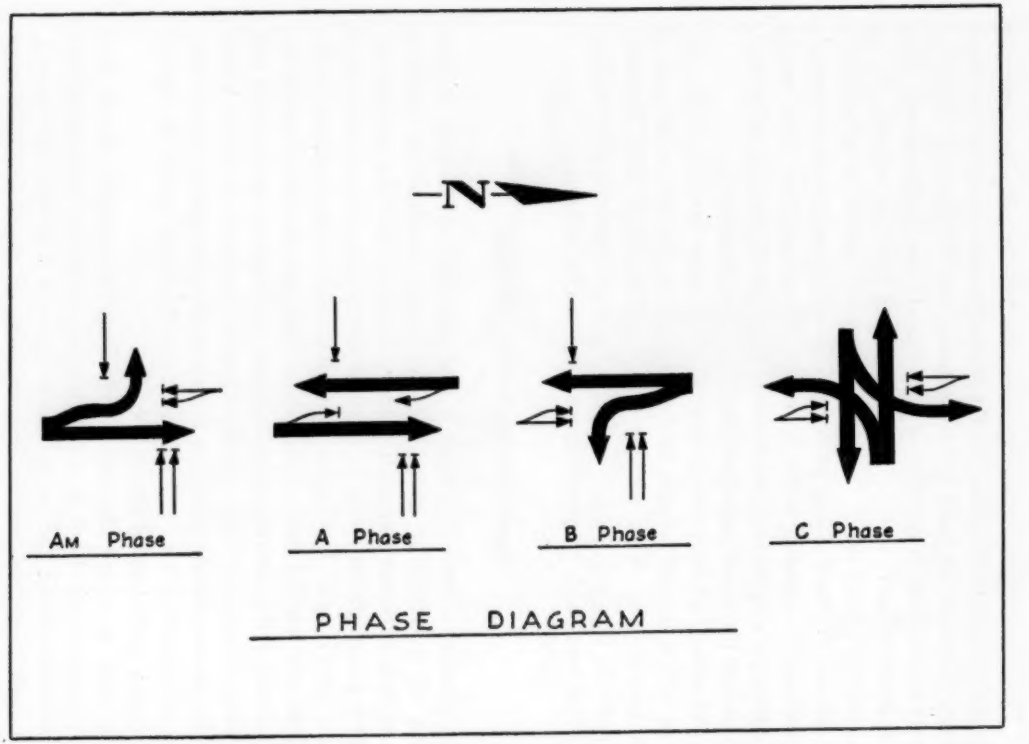


Figure 6. Phase Diagram, showing four-movement type of control.

Figure 6. Phase Diagram, showing four-movement type of control.

Figure 7. Looking south on Sepulveda Boulevard from Manhattan Beach boulevard, after roadway improvement.

An auxiliary minor movement controller provides an extendible and separately actuated phase – time for which is taken out of the beginning of the parent controller A-phase green time. This phase, called the A-minor as shown on the phase diagram, merely holds up the southbound through-movement until the northbound left-turn traffic clears.

These highway developments and signalization were considered the most feasible combination to provide the traffic-handling efficiency desired. Plans and specifications for the improvement were completed, the contract awarded in August, 1956, and construction completed in January, 1957, at a cost of $185,400. Figure 7 shows roadway after completed improvement.

Testing the Equipment

Following completion of the system, the Division of Highways conducted a testing and adjustment period to provide maximum operating efficiency. Seven pen graphic recorders provided a continuous record of the operation, both for southbound and northbound traffic.

In Figure 8, a graphical record of a typical day's operation, shows (1) the volume at any time on a per-hour, per-lane basis; (2) the cycle length being used at any time; (3) offsets in use – northbound, southbound preferential offsets, or average offsets. The chart is calibrated in percent on the volume scale and cycle lines are labeled A,B,C,D,E, and F. On the volume scale 100 percent represents 1,000 vehicles per-hour per-lane. The lettered cycles have equivalent times as follows:

Cycle A – Free running or non-coordinated
Cycle B – 60 seconds
Cycle C – 65 seconds
Cycle D – 80 seconds
Cycle E – 100 seconds
Cycle F – 120 seconds

Comparison of the volume curve with the cycle lines will show that very light traffic will require cycle A– or nonco-ordinated operation. With semi-traffic actuated intersection controllers, a

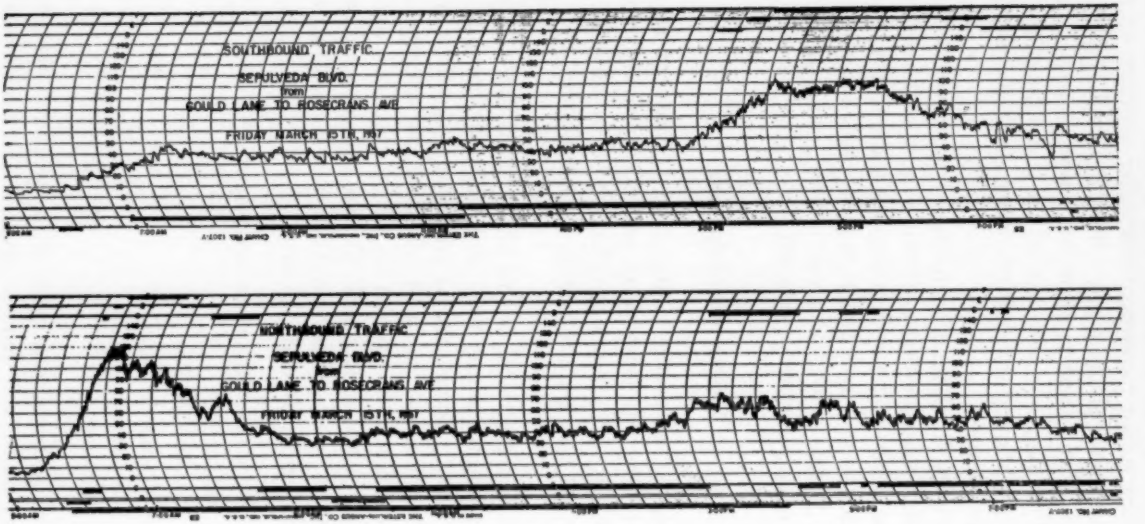


Figure 8. Graph showing day's operation of variable cycle system. The 100 on the chart represents 1,000 vehicles per-hour per-lane. Horizontal heavy lines show cycle in use, except Cycle A, which indicates desire for preferential offset.

progressive band is non-existent during very light traffic conditions and co-ordination is not necessary. Waiting time is reduced considerably. Cycle F will be required during the peak traffic load, with cycles B,C,D, and E used for traffic volumes between the heaviest and the lightest.

The traffic volumes requiring the various cycles may also be taken from the curves. The volume to select a particular cycle is adjustable. That is, by adjusting controls on the master supervisory equipment any particular amount or volume of traffic detected may be chosen to select a particular cycle. Considerable refinement in these adjustments was necessary to provide smooth operation.

The offset timing for the various intersections also required some adjustment. The southbound preferential offsets for the two-phase controllers were set later than normal in relation to the three-phase intersections to allow the B-phase overlap portion of a platoon to flow through the system. Normally the bottom of the through-traffic band is determined by the beginning of B-phase.

However, in this particular system southbound, the bottom of this band is the end of B-phase at the three-phase intersections, with the result that the two-phase intersection offsets are additionally offset by the amount of B-phase green time used at the three-phase intersections. The northbound preferential offset relationships were normal, as the bottom of the northbound band is the beginning of B-phase at the three-phase intersections.

New System Exceeds Estimates

Analysis of before-and-after-operation indicates the traffic-handling ability of the system has exceeded all estimates. Traffic counts taken before and after installation indicate an average total intersection peak hour increase of about 15 percent. The south to east evening peak hour turning movement at all major intersections has increased approximately 100 percent. The following figures show outstanding before and after peak-hour comparisons:

	Before	*After*	*Percent of Increase*
Northbound Through-Movement:			
A.M. Peak Hour at Rosecrans	2900	3250	12
A.M. Peak Hour at Gould Lane	1300	1500	15

	Before	*After*	*Percent of Increase*
Southbound Left-Turn Movement:			
P.M. Peak Hour at Marine	200	436	118
P.M. Peak Hour at Gould Lane	390	780	100
Eastbound Through-Movement:	169	448	265

The five months since improvement was completed are a relatively short period for before- and after-comparison of accident data. The following tabulation indicates a definite decrease in accident severity without showing conclusively a reduction in total number of accidents:

Type of Accident	*5 Months Before Improvement*	*5 Months After Improvement*
Personal Injury	17	10
Fatal	4	0
Total All Types	54	51

Accident records available at this time are not complete. Local authorities report, however, that left-turning accidents off of Sepulveda Boulevard have virtually disappeared. Also, the improved accident picture is concurrent with considerably increased traffic volumes.

Although the system handles an extremely heavy traffic load, there may be need in the near future for still more capacity. The equivalent of a full additional traffic lane can be obtained for each direction on Sepulveda Boulevard by peak hour prohibition of parking. All cross streets except the east legs of Marine Avenue and Gould Lane, and the west leg of Manhattan Beach Boulevard are two-lane streets. All major cross streets can be widened.

Providing additional lanes on the side streets would allow the allotment of more green time to Sepulveda, and still handle side-street traffic. The peak direction lane-capacities now handled by this system approach those normally associated with freeways. Minor cross street traffic and the extreme directional pattern make it possible to assign maximum green time to the heavy movement without unduly penalizing cross street traffic.

The outstanding achievement of the installation is that proper channelization, coupled with advanced electronic traffic control, has accomplished – at a fractional cost – a traffic service equivalent to constructing an additional lane of pavement in each direction over a two-mile section of highly developed highway.

Figure 1. La Jolla and vicinity, with existing major streets.

Major Street-Planning Problems Solved by Factual Studies

EDWARD M. HALL

Mr. Hall has been Transportation Research Director, City of San Diego, California since March, 1955. Previously, he was junior research engineer at the Institute of Transportation and Traffic Engineering at the University of California, Berkeley; and for three years traffic engineer, San Diego County Road Department. Mr. Hall is a member of the American Public Works Association and past chairman, Engineering Division, California Governor's Traffic Safety Conference. He is an associate member of the American Society of Civil Engineers and of the Institute of Traffic Engineers. In 1952, he received the Past Presidents' Award, Institute of Traffic Engineers.

LA JOLLA is a distinctive community within the rapidly growing City of San Diego. San Diego, whose population recently passed the half million mark, is the central city of a metropolitan area. The "village," as La Jolla is affectionately known by older residents, includes a twelve-square-mile area between Miramar Junction to the north and Pacific Beach to the south, and from Pacific Highway west to the ocean. A ridge and a mountain mass, Mount Soledad, separate Pacific Highway – U.S. 101 – from La Jolla, situated on the plain and hillsides facing the ocean.

San Diego adopted a revised and extended major street and highway plan in 1950. Developed in co-operation with the County of San Diego and the several cities of the metropolitan area, the plan in the La Jolla area called for Torrey Pines Road to provide access to the north and to Ardath Road, a major connection with Pacific Highway to the east and south. The master plan also selected Nautilus Street, eastward to the residential area of the Muirlands near Mount Soledad, to join four other major streets serving that area.

To provide access to Pacific Beach at the south, the plan designated La Jolla Boulevard and a facility one block away and parallel to La Jolla Boulevard through approximately half its length. This other facility followed an old streetcar right-of-way and the residen-

tial Electric Avenue, thus providing a connection into the central area of La Jolla.

Adoption of the present major street and highway plan in 1950 brought into focus the problem of major streets between La Jolla and Pacific Beach. Discussions centered on the need for greatly increased capacity vs. the adverse effect of a new major street on the highly developed property along the proposed route and existing residential street, Electric Avenue. The resulting controvery over major streets between La Jolla and Pacific Beach has been a continuing problem in major street planning.

One of the first San Diego metropolitan area transportation studies was a factual investigation of the alternate major street routes between La Jolla and Pacific Beach. To study this problem, as well as many others, an advance transportation planning team was established. It consists of representatives from the City of San Diego planning department and from the highway design and traffic engineering divisions of the city engineer; also a representative from the San Diego County planning department and the San Diego County surveyor's department. This team is physically separated from operations, and developed plans for intensive factual study of the major street requirements in the La Jolla area.

Five Alternate Routes Considered

The first step in the study of the several alternate routes between La Jolla and the community of Pacific Beach was to determine the practical routes for consideration. Figure 2 shows these several alternate routes.

Alternate I:

First is the possibility of improving the present La Jolla Boulevard, recently widened in part. Sections of the Boulevard have narrow right-of-way and there are two curves which impair it.

Alternate II:

The second route providing increased capacity between La Jolla and Pacific Beach would be the Electric Avenue line, parallel to and one block east of La Jolla Boulevard through a portion of its

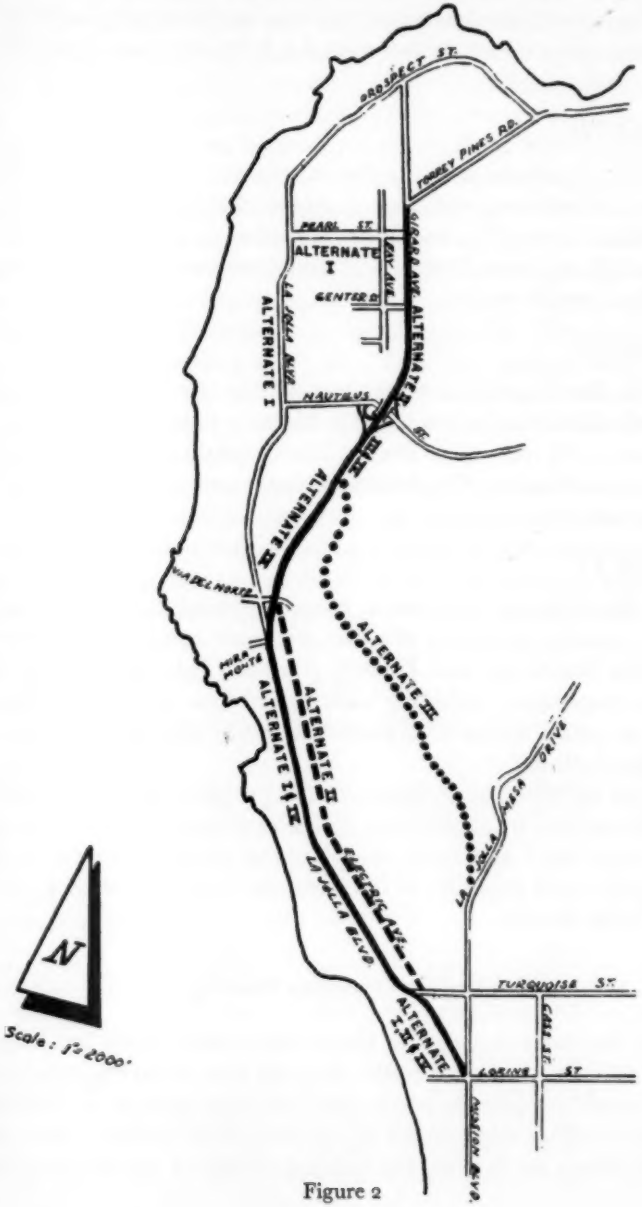

PROSPECT ST.
TORREY PINES RD.
PEARL ST.
ALTERNATE I
GIRARD AVE.
CAVE AVE.
GENTER D
LA JOLLA BLVD.
ALTERNATE I
NAUTILUS
ALTERNATE II
ALTERNATE III
VIA DEL NORTE
VIA MONTE
ALTERNATE II & III
LA JOLLA BLVD.
LA JOLLA MESA DRIVE
TURQUOISE ST.
GAGE ST.
LORING ST.
ANTHON BLVD.
N
Scale: 1" = 2000'

Figure 2

length; it would then swing slightly east and north to provide direct connection into central downtown La Jolla, and with Torrey Pines Road to the north.

Alternate III:

A third alternative was the extension of Torrey Pines Road about half way up the slope between the coastal plain and the Muirlands area. This road has the potential of a scenic parkway and a high standard facility, but would present difficulties of access and local traffic service.

Alternate IV:

The fourth possibility was to combine the existing portion of La Jolla Boulevard south of Mira Monte – most of which has been widened to 68 feet – with the old Electric right-of-way, proceeding east and north along Fay Avenue to the central portion of La Jolla's downtown area.

Alternate V:

A fifth solution considered, but abandoned as the study developed, was the possibility of a one-way pair combination between La Jolla Boulevard and Electric Avenue. This combination had several variations, including unbalanced flow on La Jolla Boulevard to retain access to commercial establishments through the Bird Rock area.

With the selection of alternates, the problem was clearly defined for the advance transportation planning team to begin accumulating factual data and study the planning concepts, traffic service, economics, and necessity of the alternate routes between La Jolla and Pacific Beach.

Planning for Optimum Development

One of the basic concepts in the transportation study has been to predict development and traffic for some year when the area under study would completely reach that optimum level of development desired. Perhaps this concept can be called the horizon year – that year to which we can see, but beyond which we are unable to see.

Fortunately, the City of San Diego had made recent aerial photographs and topographic maps covering most of the city at a scale of one inch equal to 200 feet, with a contour interval of five feet. With these 1952 maps for the La Jolla area of the city, and the records of building permits, it was possible to determine with reasonable accuracy the number of dwelling units existing in 1956. A field survey was then made in selected areas to check these estimates.

From census data and the field survey, typical densities of residential areas were developed. Although many of the R-2 zoned lots now have single family units, most R-2 areas were considered to be developed with duplexes in the horizon year. The field survey found multiple dwelling unit (R-4) densities ranging from a low of about sixteen dwelling units per acre to a high of about fifty-four per acre. An average of about thirty-five dwelling units per acre was used for future density.

The La Jolla area comprises all or part of three census tracts. The population for selected years, the percent of population increase, occupied dwelling units, the population per occupied dwelling unit, and the increase in dwelling units for each of these three census tracts are shown in Table I.

Table I

LA JOLLA AREA POPULATION AND HOUSING STATISTICS

Census Tract and Area / *Year*	*Total Population*	*Population Increase Since 1950*	*Occupied Dwelling Unit*	*Persons Per Occupied Dwelling Unit*	*Dwelling Unit Increase Since 1950*
T-81					
Bird Rock					
La Jolla Hermosa					
1950	5,451	—	1,953	2.79	—
1952	6,289	15.37%	2,321	2.70	18.43%
1956	7,612*	28.38%	2,819*	2.70*	44.34%
Horizon Year	9,600*	76.11%	3,555*	2.70*	82.02%
T-82					
Central La Jolla					
1950	2,583	—	1,104	2.33	—
1952	2,838	9.87%	1,374	2.06	24.45%
1956	3,110*	20.40%	1,446*	2.15*	30.98%
Horizon Year	7,600*	194.23%	3,534*	2.15*	220.10%

T-83

Muirlands-La Jolla Shores†					
1950	2,783	—	880	3.16	—
1952	3,538	27.12%	1,226	2.88	39.32%
1956	4,557*	63.74%	1,519*	3.00*	72.61%
Horizon Year	25,500*	816.27%	8,500*	3.00*	865.90%
Total La Jolla Area					
1950	10,817	—	3,937	2.74	—
1952	12,665	17.08%	4,921	2.57	24.99%
1956	15,279*	41.24%	5,784*	2.64*	46.91%
Horizon Year	42,700*	294.74%	15,589*	2.73*	295.96%

*Estimated
†South of Miramar Road only

The area of La Jolla, as well as the entire metropolitan area of some 500 square miles, was studied to determine the slope category of the lands. Four slope categories have been selected and these provide a device for estimating the holding capacity of the land. An extensive study of all subdivisions with more than ten lots developed since 1950 gives the average number of residential lots per acre for each slope category.

Effort was also made to relate the economic status of the subdivisions being studied and it was therefore possible to develop an average figure of 1.7 to 2 lots per acre for a Muirlands type development where large expensive homes could be expected. Where the land values are slightly less, it was necessary to increase this density, to about 2.7 lots per acre, as on the Torrey Pines Mesa.

Traffic Estimation of La Jolla Area

Based upon current practices and desirable standards, estimates of the number of dwelling units to be expected at the horizon year were developed. Acreage was then extracted for necessary supporting commercial activities, for schools, parks, and other activities necessary as part of this community. These acreage figures were developed in co-operation with the City School District and the Park and Recreation Department. The horizon year development of the La Jolla area shown in Table I was the basis for estimating traffic.

A factual estimate of La Jolla's horizon-year development was

completed to provide a sound basis for estimating automobile trip generation. A standard origin and destination survey was conducted in the San Diego metropolitan area by the California Division of Highways in co-operation with the Bureau of Public Roads and the Bureau of the Census in the fall and winter of 1952–53. The San Diego metropolitan area transportation study also used these data in a plan of freeways and major streets for the entire metropolitan area.

The traffic assignments of both 1952–53 and future traffic are based on an assumed level of service that a given type of facility should provide. Extensive studies were made to determine the level of service used and further studies generally verified these selected levels of service.

Table II

TRAFFIC ASSIGNMENT LEVEL OF SERVICE

Classification	*Urban MPH*	*Rural MPH*
Freeway	50	55
Expressway	35	50
Major Highway	—	50
Major Street—Normal	30	—
Highly developed area	20	—
Feeder	25	40
Local	15	—
Business Street (C.B.D.)	15	—

The technique used to define traffic assignment zones assumes that the centroid of each zone is the intersection of major streets. Zone boundaries are then determined by topography, community development, and census tract boundaries. If any freeways are in the area no traffic assignment zone can cross the freeway, because it would bias the assignment of traffic at the access points. This traffic assignment zoning technique has proved advantageous and appears logical since it is reasonable to assume that the center of an area's traffic activities is normally the intersection of two major streets or highways.

The first system of roads to which traffic was assigned included all the possible alternatives, to determine the traffic capacity needed in the road system to be planned. Average daily traffic was then distributed over the several roads in the La Jolla area and to the access points entering the area – that is, the inter-area traffic was brought to La Jolla area. The 1952–53 O-D assigned traffic is shown

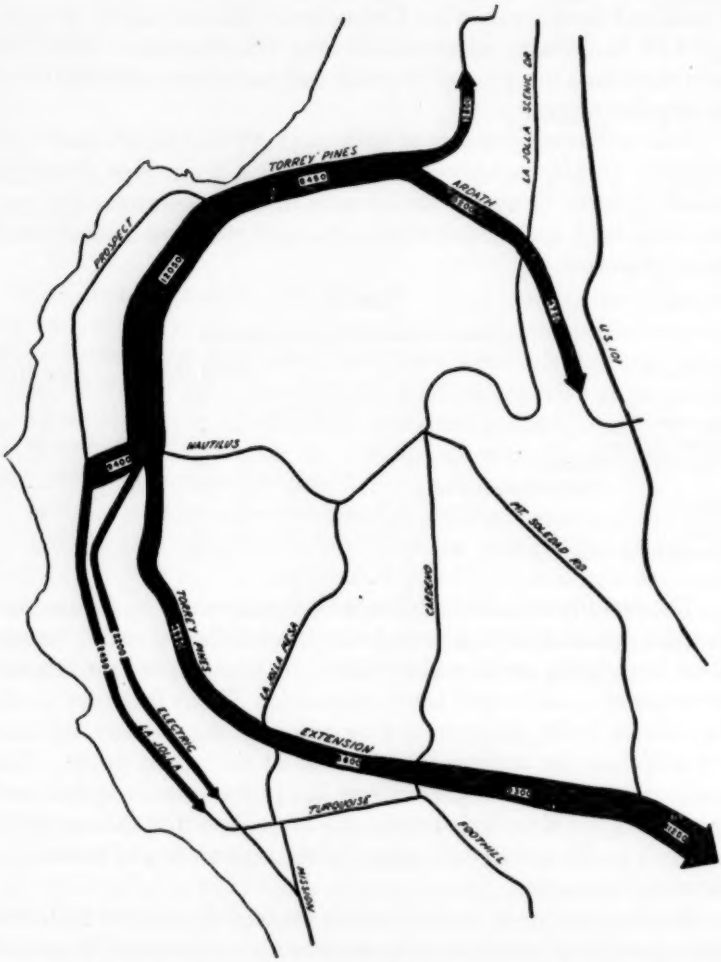


Figure 3. San Diego Metropolitan Area Transportation Study

in Figure 3. After these volumes were placed on the road net, a screen-line check was initiated to determine whether or not the study was proceeding with proper accuracy.

Using the 1952–53 data the first assignment produced 23,730 vehicles crossing the selected screen line. The actual traffic volumes counted in 1952 in an average twenty-four-hour period totaled 25,540. Thus it is seen that the assignment of 1952–53 traffic to the study plan was within seven percent of the actual counted traffic during the same period of time.

With this existing traffic assignment on hand it was possible to develop a curve showing the relationships of the interzonal trans-

$$I_{ab} = \frac{f}{T_{ab}} (G_a) \left(\frac{G_b}{\Sigma G - G_a}\right)$$

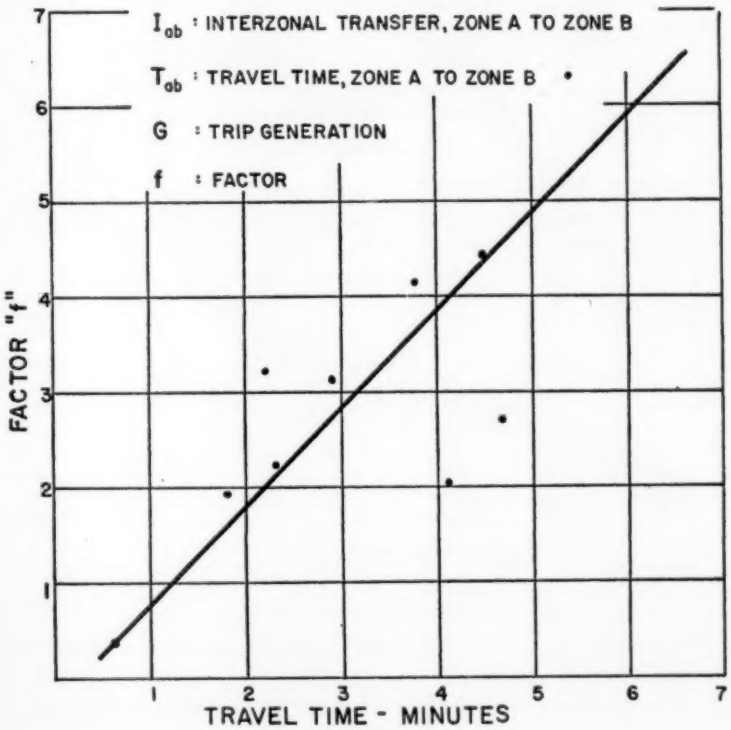


Figure 4

fers within the La Jolla area. The area originally contained eleven traffic assignment zones, one of which was later subdivided into five smaller zones.

The curve in Figure 4 illustrates the relationship of the travel-time factor "f" to travel time itself. This factor allowed the fit of a gravitational type formula to the 1952–53 interzonal transfers. This formula was assumed to remain valid for future interchanges.

Studies of trip generation per dwelling unit were made of two large modern subdivisions in addition to data contained in 1952–53 O-D. Based on these studies a figure of 6.3 weekday auto-truck trips per dwelling unit per day was applied to the planning estimates to determine trip generation in each traffic assignment zone. Further, allowance was made for non-residential trip generation to determine the total assignable trips for the average day. Table III is a trip summary by zone and includes the zone growth factor obtained from the planning studies.

Table III

LA JOLLA AREA TRAFFIC ASSIGNMENT

Trip Summary by Zones

	Interzonal Transfers			*Percent*	*Percent*	
Zone	*1952 Trips*	*Future Trips*	*Zone Growth Factor*	*Trips Remaining In Area*	*Trips Leaving Area*	*Future Intrazonal Trips*
336	600	2,600	4.33	17	83	460
337	1,650	12,050	7.32	49	51	2,135
338A		9,320		67	33	1,648
338B		4,384		72	28	775
338C	1,450	6,558	24.78	57	43	1,160
338D		12,708		56	44	2,250
338E		2,976		72	28	526
339	—	8,300	—	60	40	1,410
340	11,600	18,000	1.55	53	47	3,185
341	5,550	8,450	1.52	72	28	1,495
342	14,650	23,500	1.60	62	38	4,160
343	5,700	22,900	4.02	60	40	3,900
	41,200*	131,746*				

*Trip Growth Factor (overall): $\frac{131746}{41200} = 3.20$

Intrazonal trips were subtracted from zone totals and the developed formula was applied to calculate future interzonal transfers. The transfers were balanced through one iteration to bring

zone trip totals into agreement with planning estimates. Trips leaving the La Jolla area were distributed in accordance with the 1952–53 O-D pattern.

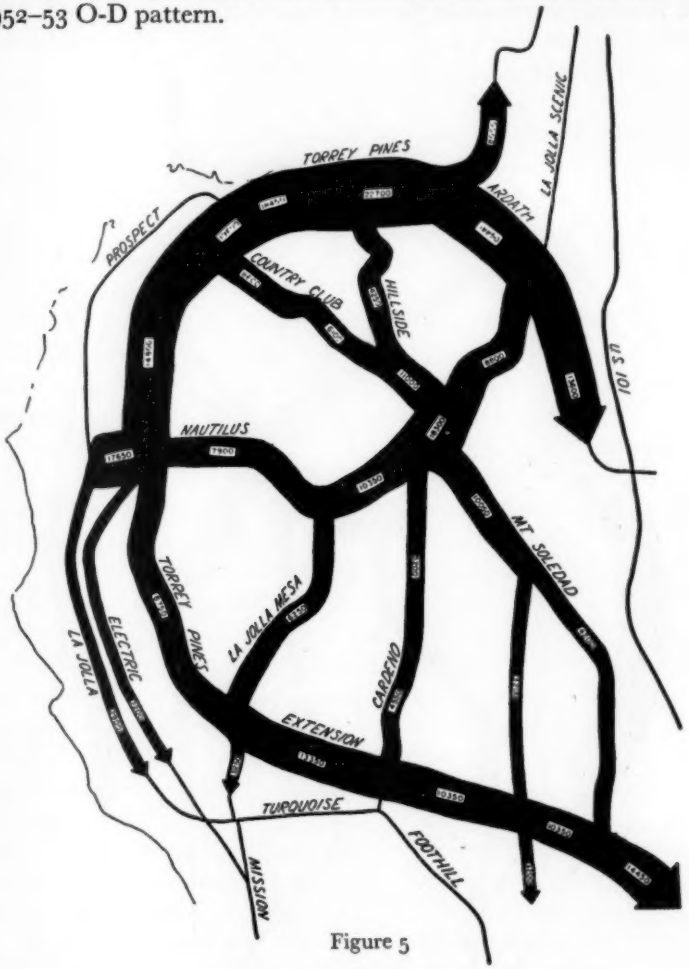


Figure 5

The overall trip growth factor for the La Jolla area was 3.2. In terms of actual figures, studies indicated 131,700 auto-truck trips in the future, compared to 41,200 auto-truck trips during the 1952–53 O-D survey.

The future traffic assigned to the first study plan, which included all alternatives, is shown in Figure 5. It is evident from the volumes that it would be difficult to justify more than one major facility

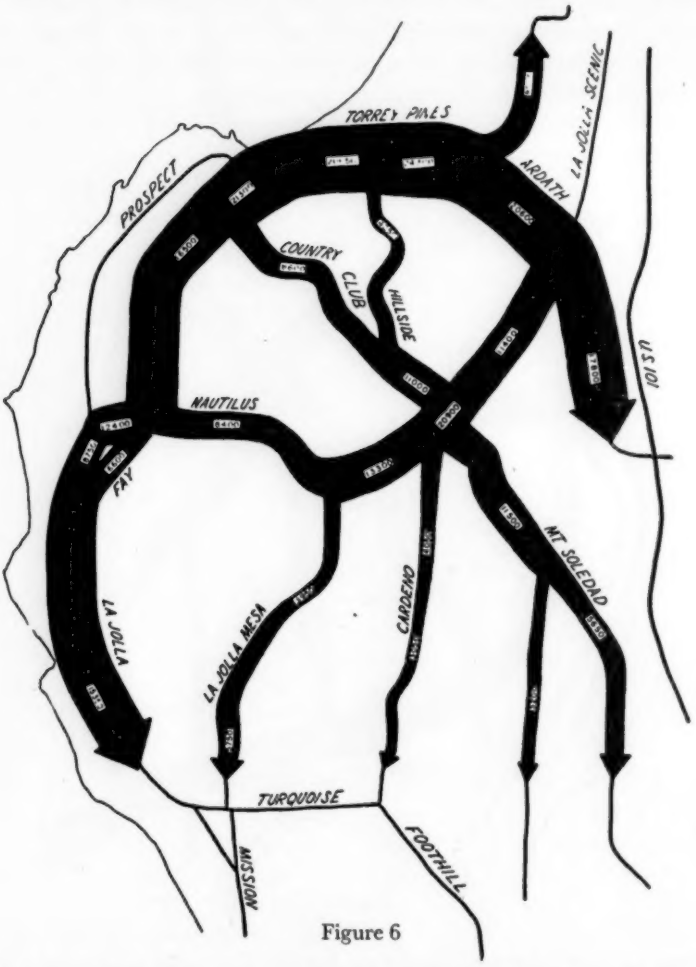


Figure 6

between the La Jolla area and the Pacific Beach areas to the south. The calculated capacity for La Jolla Boulevard developed to major street standards is 17,000 vehicles per day with parking and 22,000 vehicles per day if parking is prohibited.

On a sound factual basis it was determined that only one facility was required and that logically this should be the existing developed facility improved to its junction with Fay Avenue extended, and continuing with the development of Fay Avenue to Torrey Pines Road. The preliminary decision at this point was that Alternate IV, the Fay Avenue-La Jolla route, would be selected.

With this decision, traffic was re-assigned to the selected system of roads, with La Jolla Boulevard, Fay Avenue, Torrey Pines Road, Ardath Road and Nautilus as the major street network. This network and the estimated future horizon-year traffic assigned to the system are shown in Figure 6. The future traffic estimate provided a sound basis for design.

The traffic estimates shown for Nautilus Street in Figure 7 demonstrate that when a traffic assignment zone is crossed by a major street and when that traffic assignment zone is a long narrow configuration, the traffic estimates will be a summation of the traffic expected on all the parallel streets of any significance. In other words, the 17,650 vehicles per day on Nautilus represent the entire east-west traffic movement between traffic assignment zones 340 and 341.

A second principle has to do with the intrazonal trips in a long narrow zone in a topographic corridor, such as La Jolla Boulevard between Turquoise and Nautilus. A great deal of study was given to the problem of the intrazonal trip. Normally the intrazonal trips are not placed on the major street plan. However, in this case, 100 percent of the intrazonal traffic was placed on La Jolla Boulevard since it was the only continuous north-south street in the topographic corridor. The intrazonal trip problem can be eliminated in a topographical corridor by careful design of traffic assignment zone configuration and boundaries. The traffic assignment zone boundary that crosses Torrey Pines Road between Zones 342 and 343 is an example.

The third important principle concerns the size of the traffic assignment zones and the road pattern to be studied. The first zoning had one large zone, Number 338, on the top of Mount Soledad-Muirlands area, with La Jolla Scenic Drive going north and Nautilus going west. This assignment produced large volumes on La Jolla Scenic Drive and on Nautilus Street that were not considered reasonable. As a result, certain collector streets in the

area – Hillside Drive, Country Club Drive, and Soledad Road – were added as shown in Figure 7, thus creating additional zones

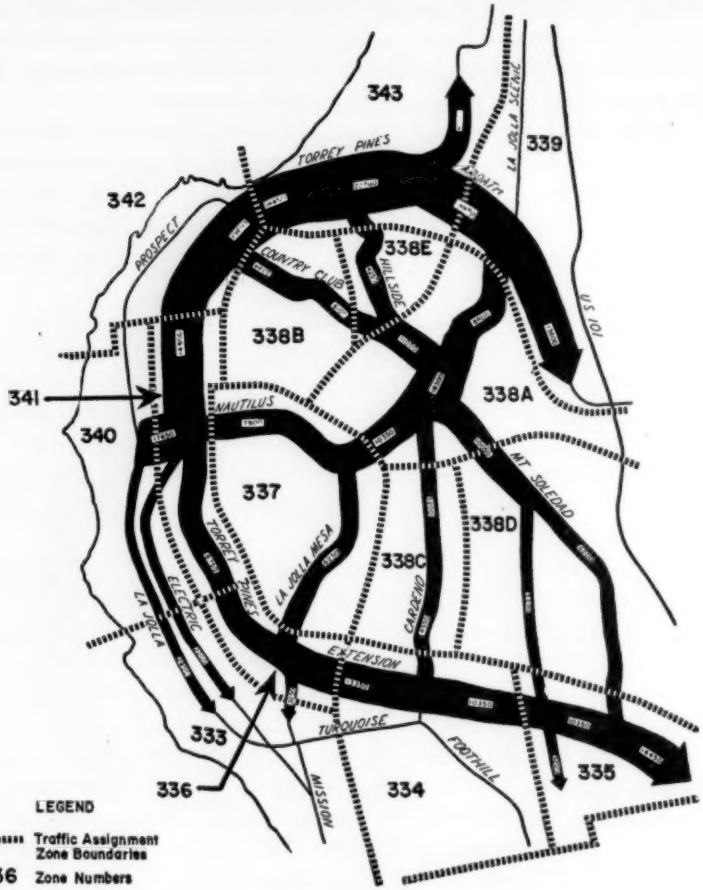


Figure 7

and producing more reasonable estimates on both the major and the collector streets.

During the planning and traffic studies, the design engineer proceeded with preliminary design and cost estimates of the several alternate routes. These were placed on standard sheets using City of

Table IV

STUDY OF ALTERNATE MAJOR STREET ROUTES BETWEEN LA JOLLA AND PACIFIC BEACH*

FACTORS FOR CONSIDERATION	*Existing La Jolla Blvd.*	ALTERNATE ROUTES			
		I Improved La Jolla Blvd.	*II Electric Avenue*	*III Torrey Pines Road Extension*	*IV Fay Ave.-La Jolla Blvd.*
Planning					
Continuity of Routes	Poor	Poor	Good	Good	Good
Community Access	Impaired by congestion	Good	Very Good	Partially limited	Very Good
Adjacent Schools	None	None	La Jolla High: Bird Rock Elementary	La Jolla High	La Jolla High
Effect on Property	—	Serious acquisition damage Bon Air-Marine	Introduces through-traffic in residential area	Conflicts with tentative subdivisions	Minimum adverse effect
Aesthetics	—	Encroaches on front yards	Encroaches on rear or front yards	Potential scenic parkway	Minimum adverse effect
Design					
Length (miles)	3.27	3.27	2.87	2.87	2.91
Design Speed (mph)	25 and 35	35	35	40	35
No. of Lanes	2 and 4	4	4	4	4
Max. No. of Signals	3	6	6	3	6
Width and Alignment	Poor alignment Narrow width	Fair	Good	Excellent	Very Good
COST ESTIMATES					
Construction	—	$ 256,000	$1,024,000	$1,127,000	$ 775,500
Right-of-way	—	896,000	425,000	1,310,000	305,000
Total	—	$1,152,000	$1,449,000	$2,437,000	$1,080,500
TRAFFIC SERVICE					
Volumes					
Present	20,500	—	—	—	—
Future					
Before Ardath Rd. Open	6,300†	18,700	11,100	20,400	18,700
Ardath Road Open	5,250†	11,600	5,350	9,150	11,600
Cost Benefit Ratio					
Before Ardath Rd. Open	—	1.8	4.0	5.2	4.7
Ardath Road Open	—	1.0	2.0	2.3	2.2

*Limits: Pearl Street and Fay Avenue to Mission Blvd. and Wilbur Street.
†Average traffic that will remain on La Jolla Blvd. if either Alternate II, III, or IV is built.

San Diego design standards. A typical advance design layout and preliminary cost estimate sheet is shown in Figure 8.

Careful consideration was given to right-of-way costs. These were obtained from the property management department responsible for the right-of-way appraisal, cost estimating, and acquisition for the City of San Diego. Every effort was made to provide maximum traffic service with minimum cost and adverse effect on property. With the design studies completed, it was possible to put together a summary of all studies in tabular form for comparative purposes.

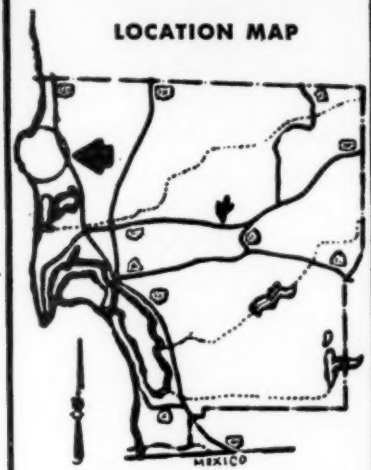
Evaluation of the Alternates

The several alternates are summarized in Table IV in an effort to develop a simple technique for evaluating them. Factors for consideration listed continuity of routes, community access, adjacent schools, effect on property, and that nebulous but important factor of aesthetics. Elements important under design were length, design speed, number of lanes, maximum number of signals, width and alignment. Cost estimates were divided between construction and right-of-way costs. Traffic service included traffic volumes, present and future, and the cost-benefit ratio.

Although Ardath Road is not an alternate route between La Jolla and Pacific Beach, the evaluation of alternate routes clearly focused attention on the importance of Ardath Road to the La Jolla area. Ardath Road has been in the major street and highway plan for a long time. It would provide direct access from the central areas of La Jolla to Pacific Highway, U.S. 101. The importance of this facility is shown by the effect on the streets between La Jolla and Pacific Beach before and after Ardath Road is opened. With Ardath open we may expect a reduction of some 7,000 vehicles per day on the Fay Avenue-La Jolla Boulevard major street. A study of the users' savings on Ardath Road indicates, over a twenty-year period, an expected $11,400,000 savings, the cost being approximately one and a half million.

Analysis of the various factors in Table IV indicated that the La Jolla area would be adequately served by developing the major street – Fay Avenue-La Jolla Boulevard – and that portion of the proposed Electric Avenue between Turquoise Street and Mission Boulevard, as shown in Figure 9. This plan assumes that Ardath

LOCATION MAP



NAME AND DESIGNATION	Fay Ave.-La Jolla Blvd.
CLASSIFICATION	B-1 Major Street
PRELIMINARY COST ESTIMATE	

ITEMS			
	RIGHT OF WAY		
	STRUCTURES		
	ROADWAY, DRAINAGE & MISC.		
	SIGNALS & LIGHTING		
	TOTAL		

SAN DIEGO METROPOLITAN AREA TRANSPORTATION STUDY

ADVANCE DESIGN LAYOUT & PRELIMINARY COST ESTIMATE

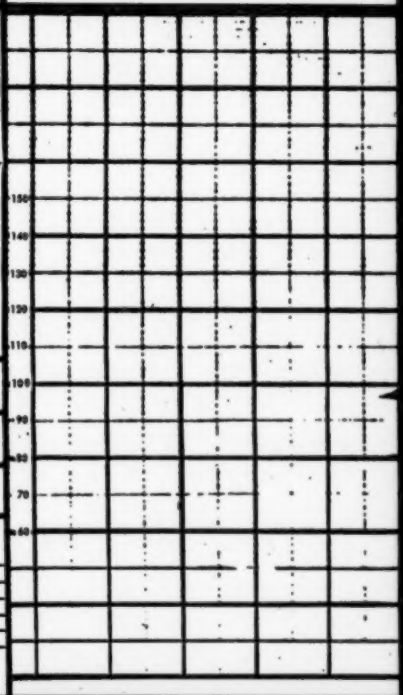
ALTERNATE 4 OF 4 ALTERNATES
ALTERNATE _____ SELECTED DATE _____

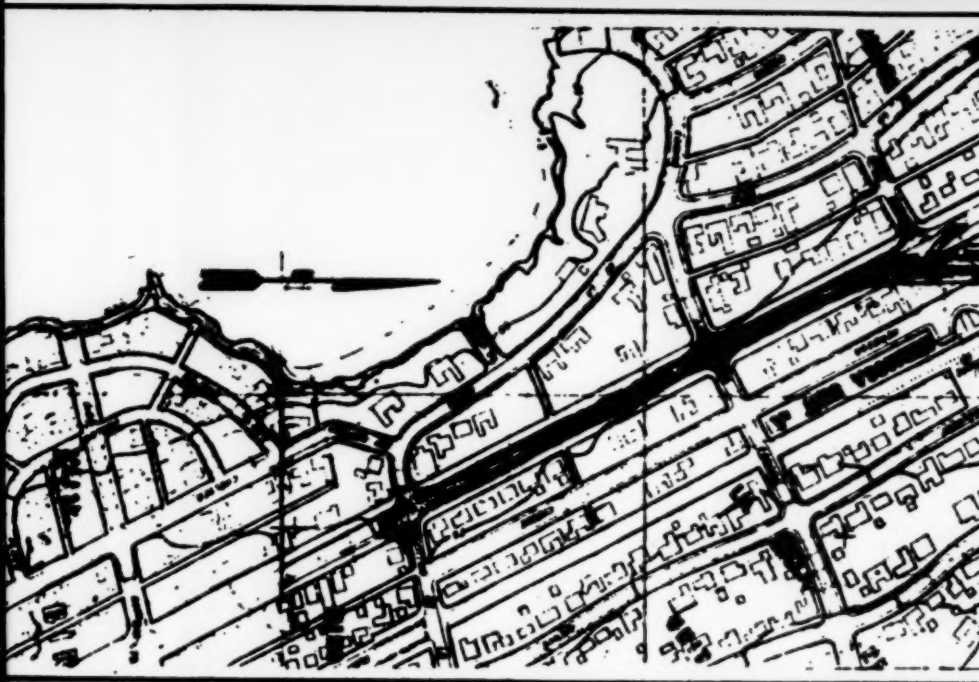
SCALE
HORIZONTAL 1"=200' VERTICAL 1"=20'

DRAWN BY P. JULIAN DATE NOVEMBER 1966
CHECKED BY _____ DATE _____

REVISIONS

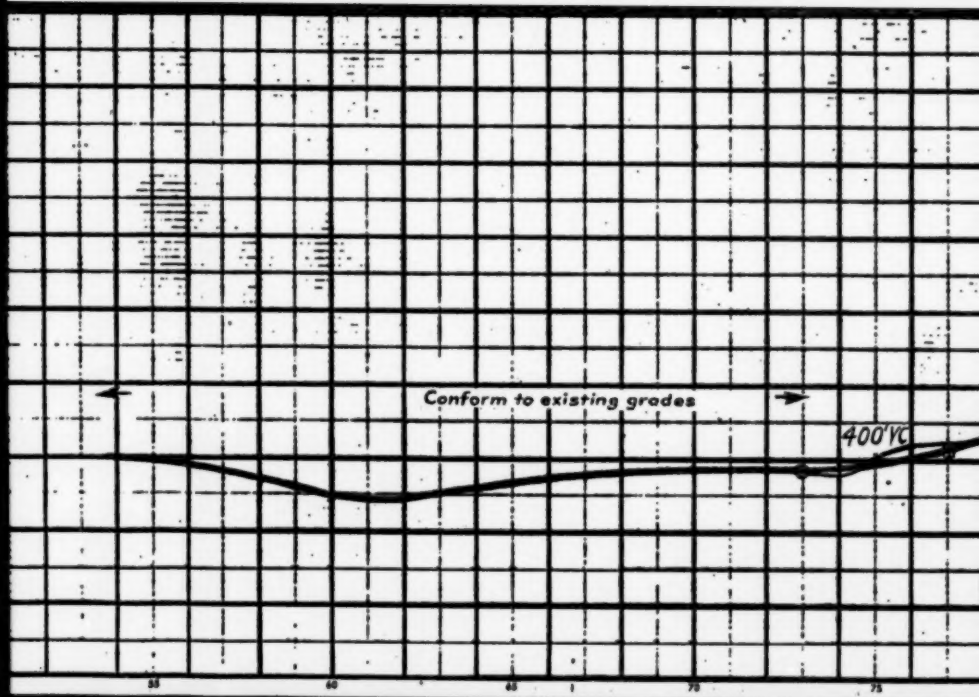
CHANGE	BY	DATE	APPROVAL

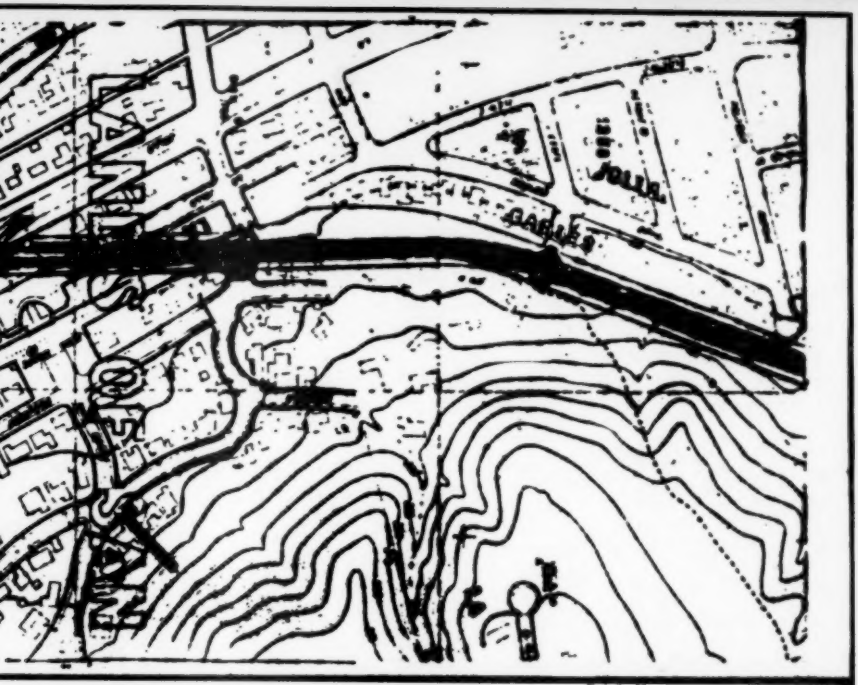




301-C

$ 44,500
18,000
62,500

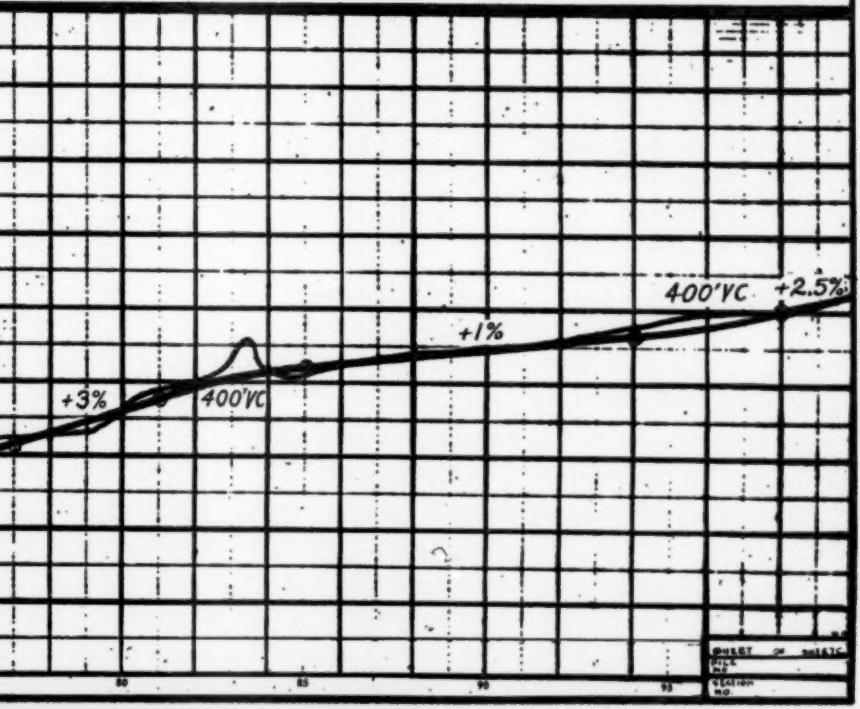




302 B

$230,000

99,500
18,000
347,500



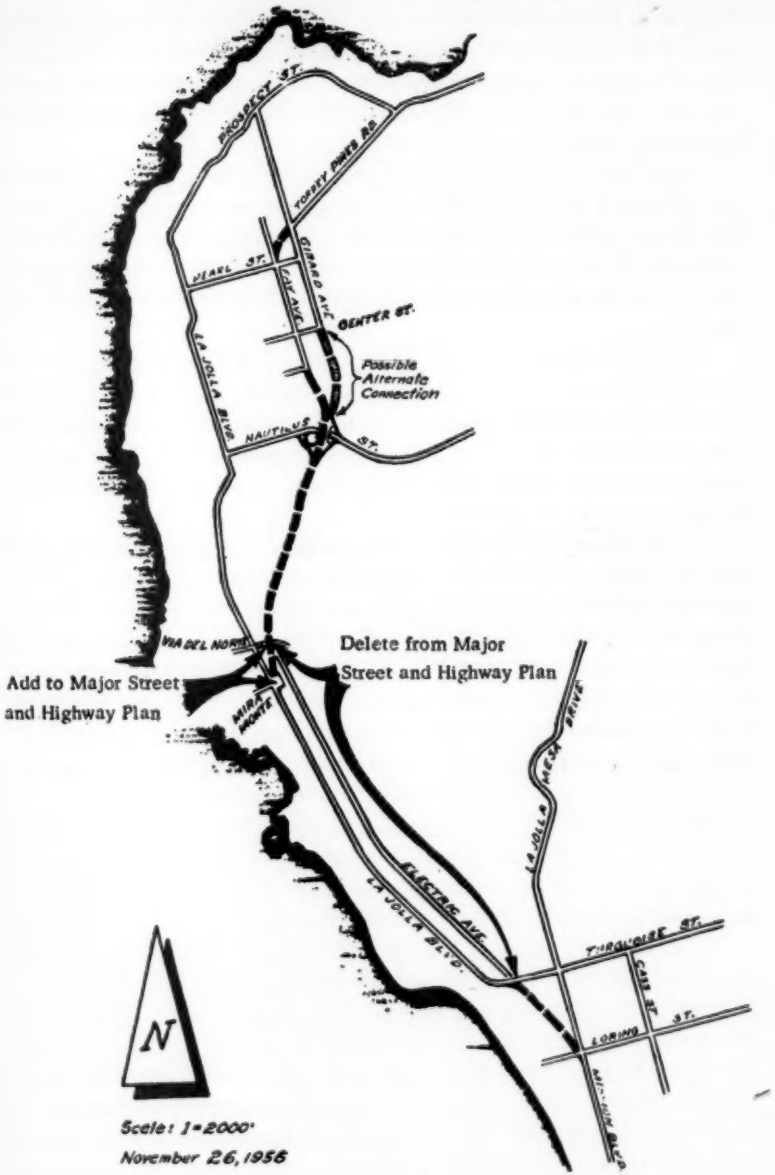

PROSPECT ST.
TORREY PINES RD.
GIRARD AVE.
PEARL ST.
COLE AVE.
CENTER ST.
Possible Alternate Connection
LA JOLLA BLVD.
NAUTILUS ST.
VIA DEL NORTE
Add to Major Street and Highway Plan
Delete from Major Street and Highway Plan
MIRA MONTE
LA JOLLA MESA DRIVE
ELECTRIC AVE.
LA JOLLA BLVD.
TURQUOISE ST.
CORE ST.
LORING ST.
N
Scale: 1"=2000'
November 26, 1956

Figure 9

Road will be constructed and that Torrey Pines Road will be improved to major street standards. Table IV led to the conclusion that Alternate IV provided maximum traffic service with minimum cost and with minimum adverse effect on property. The cost-benefit ratio with Ardath Road open is 2.2.

This factual study of alternate major street routes between La Jolla and Pacific Beach was presented to the City Council of San Diego and to the people of La Jolla and was enthusiastically received. It is now before the planning commission and it is hoped that an early decision in this long standing controversy can be reached.

If the recommended Fay Avenue-La Jolla Boulevard is built rather than the Electric Avenue alignment, a savings of nearly $400,000 in construction and right-of-way costs can be realized. The cost of the study, without the original cost of the origin-destination data, is less than one percent of the cost of the anticipated savings to the public.

It has been evident during this project that public acceptance and support can be readily obtained by a factual approach to a difficult problem. The San Diego metropolitan area transportation study expects to complete the study of the 500-square-mile metropolitan area on a similar approach, analyzing planning, traffic, and design data. These elements are combined to achieve a proper balance, to insure maximum service to the public at minimum cost, and to impose minimum adverse effects on land and its development.

Traffic Circles in Washington, D.C.

D. S. BRINKLEY AND W. L. BRAUN

Mr. Brinkley is Chief Planning Engineer of the District of Columbia Department of Highways. A career employee of that department since 1925, he has been actively engaged in all phases of highway engineering and has been in charge of the Planning Division since 1946. He is a member of the American Society of Civil Engineers, the Institute of Traffic Engineers, the National Society of Professional Engineers, and the American Institute of Planners.

Mr. Braun is Deputy Director of the Department of Vehicles and Traffic of the District of Columbia. Holding a degree in Electrical Engineering, he became the first traffic engineer of the city of Baltimore in 1937. In 1946 he was appointed Deputy Director of the District of Columbia Department of Vehicles and Traffic, the position he still occupies. He is a member of the Institute of Traffic Engineers.

WASHINGTON's street network has often been called unique, presenting unusually complex traffic patterns. Actually, it is doubtful whether our problems differ greatly from those in Chicago, Boston or New Orleans. The difficulty is fundamentally the same in every major city. All have vehicular and pedestrian congestion wherever public interest focuses on a common area.

It may surprise those who visit the nation's capital, that such a seemingly well-planned city with its broad avenues and spacious squares could produce many traffic complications. Washington is probably the only city of colonial origin that received the benefits of scientific planning in the early days of its founding.

The department of highways inherited a master street plan, dated in 1791, from Major Pierre L'Enfant, a military engineer on the staff of General George Washington.

In addition to his military duties, the major was commissioned by President Washington to draw up a manuscript plan for the capital. This he did by devising "lines or avenues of direct communication to connect the separate and most distinct objects with the principal, preserving through the whole, a reciprocity of sight at the same time." While laying out streets that would meet these requirements, his military training prompted him to include features to facilitate the defense of the city in the event of attack.

The result was a system of diagonal avenues superimposed on a conventional grid pattern forming numerous squares, circles and many six-, eight-, and ten-point intersections. The large open areas thus created lend a definite charm to the nation's capital, but as motor vehicle registration spirals upward and volumes soar to ever greater numbers, this commendable exhibition of foresight has backfired into a congestion problem that could hardly have been worse had the city been permitted to grow willy-nilly as have most of our municipalities.

This article deals with circles, the complexities of vehicular and pedestrian control arising from them, and the methods employed to overcome the deficiencies inherent in all rotary movements of traffic. It is unfortunate that urban highway planners and traffic engineers must devote most of their time and talents to overcoming deficiencies in outmoded city street systems, rather than in developing new municipal areas. In this endeavor, through their knowledge of past experience and advanced concepts they could apply the modern techniques that would greatly facilitate the handling of America on wheels.

It seems appropriate here to recognize an obvious fact that most highway planners are reluctant to accept; that is, the time is not too far away when we shall be forced to devise plans that will discourage further increase in motor vehicle use instead of bending our efforts to sacrifice more and more tax-producing land on the altar of the mechanical monster.

True, the freedom and ease of movement provided by the automobile has probably been the backbone of an economically strong and healthy nation; but we are approaching the point where, without some other consideration, we are apt to be strangled by the very mechanical marvel that provided us with our envious prosperity. Some may consider this position heresy, but it must be admitted that the opinions are well founded and merit serious thought.

Two Departments Combine Planning

The cause for circle congestion stems from two principal sources: inadequate roadway capacity in the rotary to absorb the many lanes feeding into it, and the weaving movement that develops as

motorists attempt to steer a course to the exiting street they desire to use. The heavier the entering volumes become, the more confused and hazardous the weaving movement.

The relief that can be provided by traffic control devices is extremely limited, especially where more than one major street enters the area. Washington has employed every conceivable antidote in the treatment of circles – from the relatively simple rotary without signal control to the complex arrangements devised at Dupont Circle, described in the following paragraphs.

In approaching the problem it is, of course, necessary to have full and complete traffic information affecting the subject location. In this regard the Department of Highways and the Department of Vehicles and Traffic in the District of Columbia work together. The responsibility of Vehicles and Traffic is operational control, and that of Highways is design and construction. The two combine in the geometric planning of the various projects – a combination that explains this article's co-authorship by a representative from each department.

The planning division of the highway department collects and analyzes all traffic information and prepares it for the joint study. The factual data required generally include traffic volumes by type, turning movement, accident records, pedestrian counts, local origin-and-destination movement, and forecast of future volumes.

Dupont Circle Traffic Surveys

Dupont Circle, prior to its major reconstruction in 1949–50, was probably the most complex rotary traffic problem in Washington. Situated on the periphery of the central business district, it is a point where five streets converge to form what is commonly known as a ten-point intersection. Two of the radial roadways, Connecticut and Massachusetts Avenues, are major arterials that directly connect the heavily populated areas of Washington and nearby Maryland with the central business district.

Traffic volumes entering this rotary exceeded 50,000 vehicles daily back in 1944 when it became evident that immediate corrective measures were necessary. A grade separation was indicated, but the question was, which of the two major arteries should be

carried through? To determine this a novel local origin-and-destination survey was devised – that is, the method was a bit unusual thirteen years ago, but is probably used extensively today.

An appropriately printed, serially marked and colored card, lettered to denote each of the radial streets, was issued to every driver entering the circle. The cards were then collected at all exits by fifteen-minute periods. By comparing the serial numbers listed at the points of ingress and egress, it was possible to determine the rate of vehicular flow as well as the points of origin and destination for short periods.

This survey was conducted in April 1945, from 7 to 9:30 A.M. and from 4 to 6:30 P.M. Thus both peak periods were completely covered. In addition, totalizers were posted at various intervals around the circle to classify and manually count traffic passing these selected points.

To insure further accuracy, this count was supplemented by machine tallies on both sides of the feeder and distributor lanes for a week before and after the survey, so that the natural drop in volume caused by drivers wishing to avoid the survey area could later be adjusted to show actual densities. Time studies of streetcar and bus movements were also made to complete the pattern. In all, the survey required the use of sixty-five men, including police officers and supervisors, who were thoroughly briefed on the procedure the day before the survey.

New Design Based on Survey Data

After the results were tabulated, we found we had obtained a sample of the circle are a traffic pattern that was close to 100 percent. These data were interpreted and presented in graphic illustrations showing the direction, rate of flow, and volume of traffic through the circle complex. The upward trend in population and vehicular registration, applied to the known quantities, formed the basis on which the 1955 traffic pattern could be forecast with reasonable accuracy.

It may seem strange that the forecast was projected to 1955, rather than twenty or twenty-five years from the date of the analysis. The only answer is that, at the time, a prediction of traffic volume ten years into the future seemed adequate.

The immediate result of the survey, however, was to prove that Connecticut Avenue carried the largest percentage of through-traffic: 71.4 percent of all vehicles entering from Connecticut Avenue remained on that street upon leaving the circle; 58 percent of the Massachusetts Avenue traffic left the circle on that same street. On the basis of this information we recommended that the grade separation be designed in the line of Connecticut Avenue.

This decision was not without challenge. Some citizens' groups, and even individuals in our own organization, believed we could not develop a design that would accommodate the many features needed. The major problem stemmed from the heavily patronized streetcar line that also traversed Connecticut Avenue, for which loading facilities had to be provided within the circle area.

The situation was further complicated by citizens' insistence that access to loading platforms had to be from the outer sidewalk around the periphery of the circle and not by dropping down on stairways placed at the center of the circle. This plan meant, of course, that the streetcar line had to be carried from the center lanes of Connecticut Avenue approaching the circle to a location under the circle that would permit passenger access from the outer sidewalk along the arc of the circle above, while the free wheel tunnel remained on tangent throughout.

The method by which these things could be accomplished presented a vexing problem until we suddenly struck upon the idea of tandem portals. In operation, the streetcars enter a ramp located in the center of Connecticut Avenue and after reaching the portal, curve immediately and parallel the second ramp which serves free wheel vehicles. The roadways remaining on the surface of the Circle are divided. Massachusetts Avenue has separate lanes on an inner roadway while the other entering streets are directed into an outer roadway.

Traffic Operation at Dupont Circle

Traffic at Dupont Circle, before it was underpassed by Connecticut Avenue, was regulated by twenty-three signals designed to control vehicles both entering the circle and proceeding around it. Notwithstanding the multiplicity of approaches – ten in number – the

controller was quite simple. It merely consisted of a three-interval timer operating on a total cycle of 120 seconds.

The first interval was for fifty-five seconds and permitted traffic to enter the Circle at every other approach; the second interval of forty-five seconds permitted traffic to enter from the alternate approaches. During both of these intervals traffic could proceed around the circle or leave at any street.

This method of alternating traffic entering the circle by adjacent streets had two advantages. First, it provided a greater weaving distance between the point of entrance and exit of the individual vehicle, and second, it limited the volume of traffic in any one segment of the circle. Fortunately also, the two most heavily traveled streets, Massachusetts and Connecticut Avenues, were adjacent to each other at their entrances to the circle and the traffic from each did not enter the circle at the same time in the same segment.

This method of control was by no means ideal. Many points of conflict occurred between vehicles entering the circle and those proceeding around it intending to leave at the next exit. Worst of all, both the northbound and southbound streetcar tracks of the Connecticut Avenue line were on the west half of the circle. The result was that every streetcar proceeding north was traveling in the opposite direction to the normal counter-clockwise movement of all other traffic. Strangely enough, the frequency of accident occurrence involving this unorthodox situation was relatively low. Perhaps motorists' natural antipathy to drive on the left pair of two pairs of tracks was the reason for this good fortune.

The third interval of the signal cycle was an all "red" interval of twenty seconds during which pedestrians were provided a safe crossing, not only of the streets entering the circle, but across the roadway of the circle itself to gain access to the park in its center. There were no "walk" signals, but pedestrians were informed by a small sign on each signal post to walk when all the signals were red.

Tradition and convenience must be served even in traffic control. The relatively large park area of Dupont Circle with the fountain in its center, its stately trees, and shrubbery in abundance, has always been attractive to Washingtonians. Patrons of the smart shops along Connecticut Avenue, elderly people out for their daily constitutional and nurse maids with their charges from apartment

Figure 1. Air View of Dupont Circle, looking south on Connecticut Avenue, showing the tandem portals.

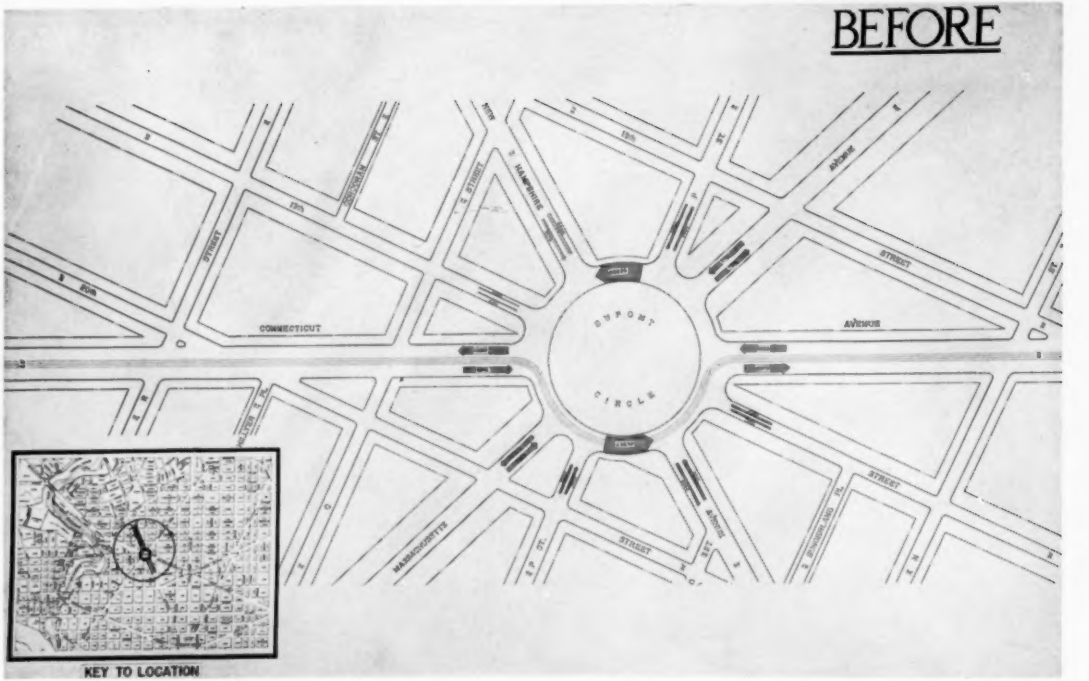


Figure 2. Dupont Circle before reconstruction, showing street-car rails in both directions around one side.

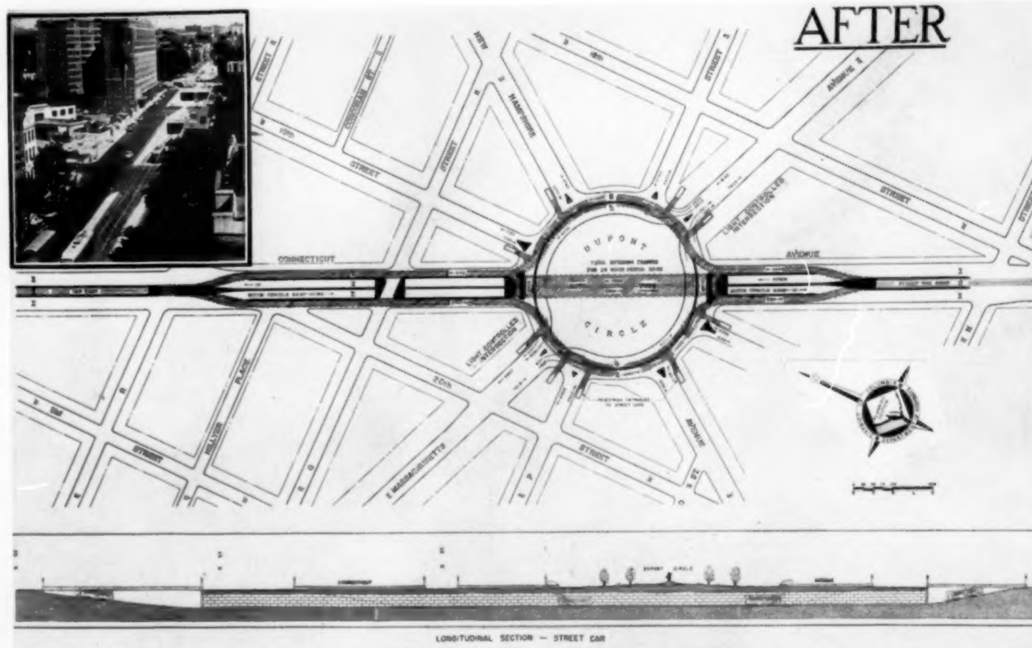


Figure 3. Dupont Circle after reconstruction was completed in 1950 at a cost of $4,400,000.

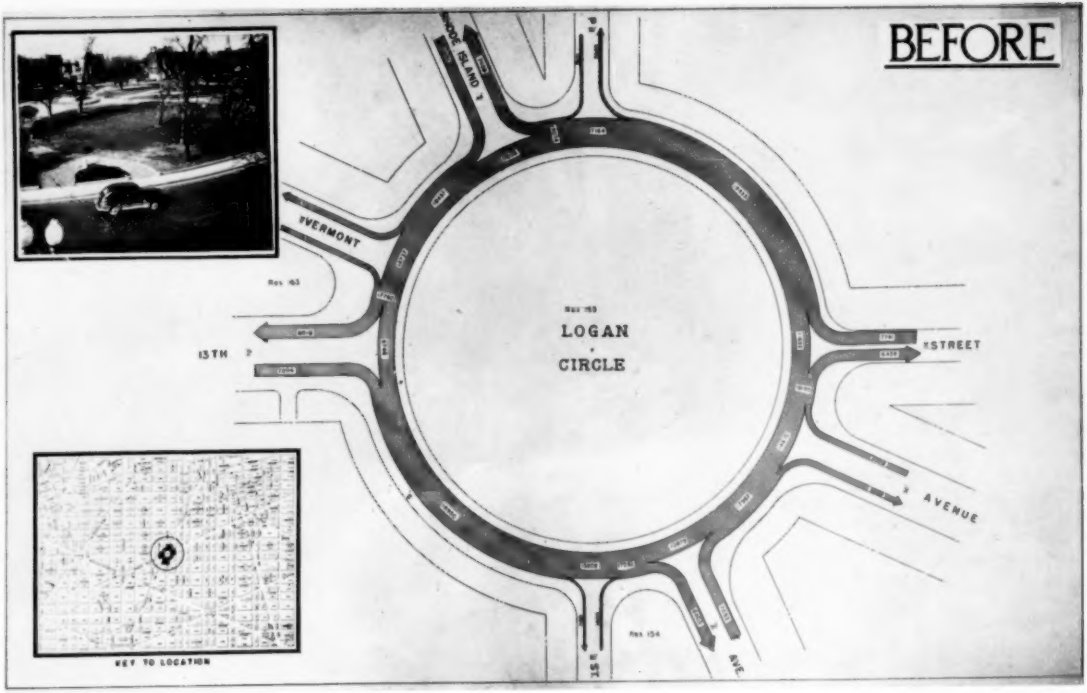


Figure 4. Logan Circle before reconstruction.

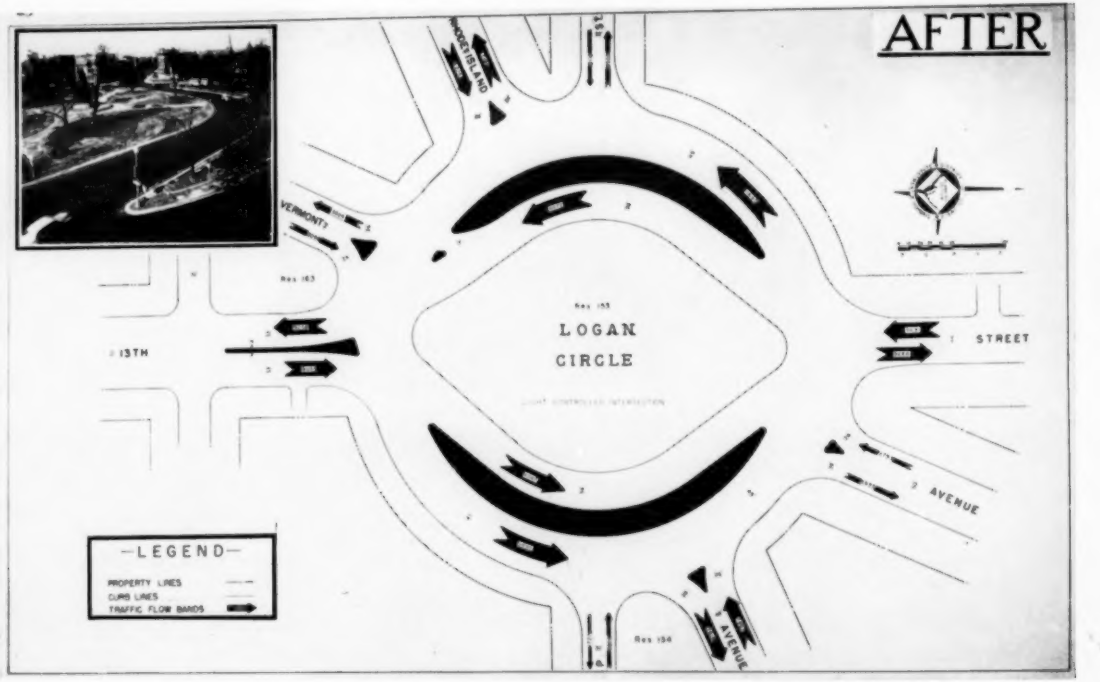


Figure 5. Logan Circle after re-designing completed in 1950. Roadway paving cost: $127,000.

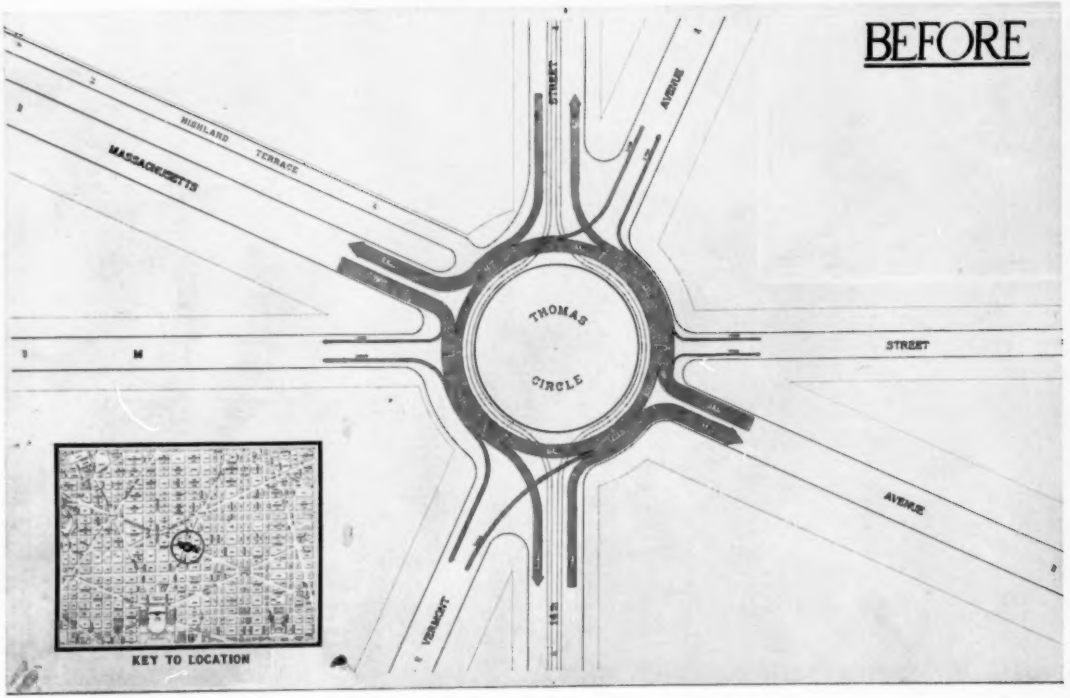


Figure 6. Thomas Circle before its reconstruction in 1940.

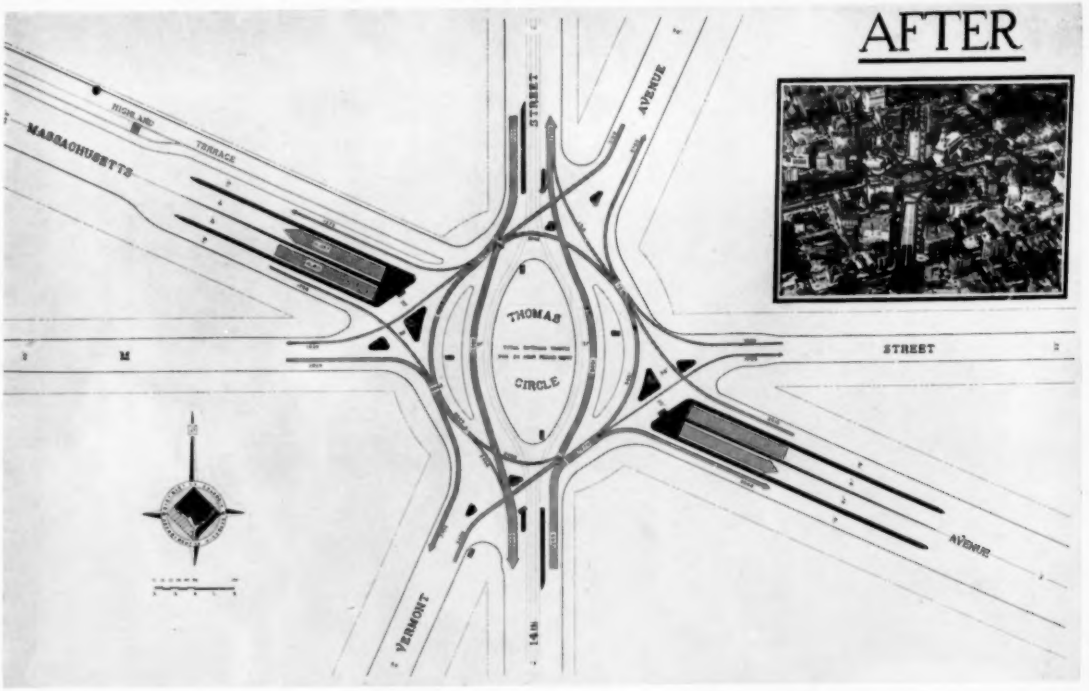


Figure 7. Thomas Circle after it was completed in 1940 at a cost of $566,000.

houses in the vicinity, have always found this an inviting spot to pause for a short rest. It was obvious, therefore, that any signal control of traffic must also provide an opportunity for pedestrians to cross the roadways safely. This feature was mandatory in designing the signal system to control traffic under the conditions resulting from reconstruction of the circle roadway facilities.

By underpassing Connecticut Avenue – one of the two major traffic arteries – the number of vehicles previously required to go half-way around the circle to continue on Connecticut Avenue could now do so without conflicting with Circle traffic. Likewise, by building separate roadways for Massachusetts Avenue through-traffic, conflicts with other traffic were reduced from six to two in each direction.

Signal System for Pedestrians and Cars

Designing a signal system to provide uninterrupted traffic flow not only for Massachusetts Avenue but around the outer roadway, and at the same time protect pedestrian crossings by signals, presented a challenge to the ingenuity of our signal engineer. The practice in Washington has been to use pedestrian signals only where the pedestrian could be given an absolute right-of-way, never in conjunction with a full green light for vehicular traffic. Under these conditions, a pedestrian proceeding on a "walk" light is subjected to right and left turning vehicles moving across his path. This policy was adhered to at Dupont Circle.

Pedestrian ingress and egress to the center of the Circle were provided at six of the possible ten street entrances. In every instance, the pedestrian is first directed by "walk" signals to an island at the throat of the entering street, which divides the entering and leaving traffic; and from that point, also by signals, across both the outer roadway and the Massachusetts Avenue roadway. At some locations he can proceed across both roadways without interruption; in others he can proceed across one roadway to the dividing strip and then wait a short period before given a signal to cross the other roadway.

The final design of this signal system produced a progressive movement of traffic around the Circle, together with a movement

of traffic through the Massachusetts Avenue roadways and continuing through the signals along Massachusetts Avenue, both east and west of the Circle. The result was gratifying.

Equipment for the Dupont Circle system consists of sixty "walk" signals, twenty-six three-light signal heads and two four-light signals heads – a total of eighty-eight signals. The controller operating these signals was, when it was first installed, the largest in existence in the number of circuits it contained. As far as we know, it is still the largest since it provides for eighty separate circuits. The controller is housed in one cabinet, with the panel board and relays housed in two other cabinets so as not to run the risk of overloading a single bus bar.

The controller is of the fixed-time type, interconnected with the master signal system control, and operates on an eighty-second cycle. At Dupont Circle this cycle is divided into sixteen separate intervals of five seconds each, the sequence of which determines the progression of traffic through and around the circle. The controller also operates the "walk" signals during the proper intervals so as to cause the least delay to traffic. The time given to the individual "walk" signals varies, but it is never less than twenty seconds for any one roadway.

No attempt is made here to describe in detail the operation of this system. It can best be understood by studying the sixteen signal operation drawings. We ourselves do not attempt to memorize the sequence of operation. Whenever a problem arises or some change is indicated in the traffic pattern, we work from the drawings and trace the movements and timing to the location where attention has been directed.

Logan Circle Re-designed

At Logan Circle, located in northwest Washington just on the northern edge of the business district, four streets converge. Two of these are major thoroughfares. Rhode Island Avenue carries a heavy volume of cross-town traffic; Thirteenth Street is one of our most important north-south radials. South of the Circle, Thirteenth Street is seventy feet wide and operates as a two-way street twenty-four hours a day. North of the Circle, Thirteenth Street is forty-four feet wide and operates as a reversible one-way street. It is one-way

southbound in the morning rush period and one-way northbound during the evening rush period. For the remainder of the day it is a normal two-way street.

In a recent Bureau of Public Roads study of Thirteenth Street's peak period operation, traffic volumes reached 1750 vehicles per lane per hour of green through the one-way sections of that street north of Logan Circle. Experience in designing the signal system at Dupont Circle proved helpful when it became necessary to provide controls at Logan Circle. Here, the major arterial, Thirteenth Street, was extended through the Circle, as Massachusetts Avenue through Dupont Circle. One difference is that access from the southbound roadway was provided for vehicles wishing to enter Vermont Avenue.

The signal operation plan before Logan Circle was re-designed was similar to the former Dupont Circle plan. Traffic on both Thirteenth Street and P Street approaches entered the Circle during the first phase for thirty-five seconds; in the second phase of thirty seconds, Rhode Island Avenue and Vermont Avenue traffic entered. All traffic proceeding around the Circle during these two phases was allowed to run. A third phase of fifteen seconds stopped all traffic to permit pedestrians to cross. This signal sequence coupled a major and minor street during both vehicular phases, resulting in a more uniform distribution of traffic around the Circle.

One minor disadvantage was Vermont Avenue's closeness to Thirteenth Street where they entered the Circle, allowing an extremely short weaving area for vehicles desiring to cross paths.

Before Logan Circle was re-constructed sixteen three-light signal heads controlled the traffic. After re-construction, thirty-six three-light units and forty pedestrian signals were installed. All of these signals are operated by a single controller with seventy-eight circuits. This controller is connected to the master central control and therefore operates on a cycle of eighty seconds.

The beginning of each successive phase is not at five-second intervals, as at Dupont Circle: one phase starts eight seconds after its preceding one, and three start four seconds after. Reasonable progression of traffic is obtained in the outer roadway around the circle. Progression at twenty-five miles an hour is obtained through Thirteenth Street in both directions. The fact that Thirteenth Street is a reversible one-way street had no major bearing on the design

of the signal system. Figures 4 and 5 illustrate changes in the geometric design of Logan Circle.

Thomas Circle Rebuilt in 1940

Thomas Circle, on Massachusetts Avenue about five blocks east of Dupont Avenue, involves the intersection of four city streets, one of which contains a streetcar line. Before reconstruction began in 1939, more than 60,000 vehicles entered this rotary in an average twenty-four-hour period. The circular roadway could handle only about half this number without serious congestion.

The obvious solution was a grade separation, and traffic studies indicated that the bulk of through-movement was on Massachusetts Avenue. This fact simplified the problem to some extent because the streetcar operation, which is on Fourteenth Street, did not complicate the structure design as it did at Dupont Circle.

Here again, the second heaviest flow, Fourteenth Street, remained on the surface and was given separate roadways through the Circle – divided from an outer circular pavement by islands, as shown in Figure 7. The construction of the underpass relieved the pressure on the surface rotary by more than 50 percent. All traffic movements are controlled by signals similar in design to those at Logan and Dupont Circles.

"What place does the circle have in the planning of a modern street system?" Opinions vary to a considerable extent. Certainly, open park-like areas tend to relieve the monotony of paved trafficways and lend a certain distinction to any route of travel. So, aesthetically, a circle or square can be considered an advantage.

However, from the standpoint of traffic operation they are almost invariably a bottleneck, and in many situations, hazardous. This fact may lead to the conclusion that circles are most acceptable on low-volume thoroughfares. The question then arises, "Are there any low-volume thoroughfares remaining in our urban areas?"

In Washington, they are becoming fewer with each succeeding year. And also, in Washington – as in many other cities – there is no other solution to multi-point intersections. Perhaps it must remain an individual judgment as to whether circles should be deliberately planned or avoided.

Education and Training For Highway Engineering Employees

ROBLEY WINFREY

Mr. Winfrey has been the training officer for the U. S. Bureau of Public Roads, Washington, D. C., for the last five years. He is personnel officer also. Prior to coming with the Bureau he was for thirty years on the engineering staff of Iowa State College, Ames. There his main interests were research and teaching of highway engineering, highway economics and traffic. He has addressed highway conferences and published papers on the training and use of engineering personnel.

SCIENCE and technology bring forth improved ways of accomplishing the material and intellectual needs of our complex society. We achieve labor-saving devices, methods, and procedures.

Our labor force today is the largest in the history of the country. And there is a much larger number of women workers. True, we have eliminated much child labor and the ten- and twelve-hour day. On the other hand, we have added the aeronautical industry, the electrical industry, the electronic industry, and the business machine industry. To supply the labor to manufacture labor-saving devices and to operate these new industries, it has been necessary to transfer workers from rural areas and from occupations that produce the products to occupations that produce research, tools, and devices by which our operations can be achieved.

The Use of Engineers

Throughout these accomplishments one thing must be kept in mind: We need human beings through this entire chain of endeavor. No machine will do the thinking for the human being. Day-by-day decisions in every office, home, and endeavor are human-made decisions.

The accomplishment of any organization cannot be greater than the ability of its employees. On these employees, their skills, knowledge, and ability is placed the responsibility for accomplishment. It is highly desirable, therefore, that every employee be

studied to determine his ability and the particular responsibilities he can perform to advantage.

Examination of almost any highway department will disclose that many professional engineers are used each day on duties far below their level of education, ability, and judgment. This undesirable use of professional talent is brought about by the engineers' own failure to delegate duties to assistants. Further, many workers are not given opportunity to display their abilities and talents in other than menial and routine types of duties. On the other hand, because of our general full employment, we encounter difficulties in hiring enough assistants to give the top-level worker sufficient time for high level operations.

Practically all of the shortcomings in the use of professional, high-level talent can be overcome by good personnel management, good organization and management. Personnel management includes the training and development of employees.

World War II accelerated the application of electrical, mechanical, and scientific devices in the accomplishment of many operations in government, business, and industry. We discovered then how to train persons to perform tasks we thought could be performed only by the highly educated. War experience and scarcity of trained help in the postwar period resulted in a large expansion by employers in the specific training of employees.

Change in Engineering Education

Our colleges and universities are moving more into a type of engineering education that stresses the fundamental physical sciences, related to engineering, and certain phases of the humanistic social group of studies, at the expense of teaching fewer skills. Less time is now spent on drawing, surveying, laboratory testing, and forms of shop work than heretofore.

The civil engineering curriculum no longer contains courses in office practice that simulated the type of work engineers would do when they hired out to consulting engineers, government, or industry. We are graduating at the bachelor's degree level engineers more highly trained in engineering sciences and the humanities, less in the arts and skills of engineering.

This basic change makes it more desirable that employers,

particularly of civil engineers, give attention to additional training and education of the college graduates whom they hire. It is necessary to train them in the ways a particular company wishes to perform its operations, and in applications of basic engineering fundamentals learned at college.

Change in Employment of Engineers

In 1890 the United States as a whole employed about 280 workers in industry to one engineer. This number has steadily decreased until the ratio is about fifty workers to one engineer. It is evident that the role of the engineer has become more and more important. More attention needs to be given to the training of the engineer to carry these additional loads.

Highway departments need engineers in planning, construction controls, in materials control, in traffic engineering, in soils analysis, and in the many types of portland cements and bituminous materials – far in excess of that need a few years ago. In fact, it was not until the middle 1920's that soil engineering was recognized by highway departments. Today it is basic to all good highway design. Highly trained men in these phases of highway operation are essential. But our colleges and universities are educating students in the *sciences* (not practices) on which engineering is based. The highway departments must train these graduates in the *application* of these sciences and in the procedures to be followed.

The shortage of professional engineers is apt to continue for years. Out of this shortage, however, is growing one significant change in management. We finally have realized that our ratio of engineering aids and technicians to professional engineering employment is entirely too low. A study reported to the Highway Research Board in 1956 indicated that the forty-eight state highway departments employed about one and one-quarter engineering aids or technicians to one professional engineer.

To accomplish construction of the new highway program and to use the engineer more effectively, strictly on professional work, the ratio of engineering technicians to professional engineers should be increased to about three to one. This increase can be achieved through a systematic training program and by a more rigid management of the professional engineers to see that they do professional

engineering the greater share of their time, not administrative, clerical, and technician work. Accomplishments along these lines can be achieved by every highway department.

Training, Education, and Know-how

Training and education are somewhat interchangeable words, but a differentiation will be made in this article.

One of the differences between training and education is that training suggests exercise or practice to gain skill, endurance, or facility. Education may be concerned primarily with the instilling in the mind of knowledge about a subject. This knowledge may be somewhat abstract in character or it may be knowledge of how to perform. On the other hand, the knowledge of how to design a bridge does not indicate that the possessor thereof could design the best bridge for a particular requirement.

The comparison of training and education brings in a third term we shall call "know-how." Know-how seems to bridge the area between education and skill. It is quite conceivable that one could be expertly trained in a subject or in a maneuver as well as being highly educated, but in the end it is the know-how, the ability to produce a satisfactory result, that employers are looking for. Much of this know-how has to be achieved by experience on the job in some form or other.

How Employees May Be Developed

Bearing in mind that the highway department wishes to employ engineering personnel with necessary education and proper training to apply their know-how to satisfactory achievement, we can discuss how employees can be developed.

First, an employee can start out with what education and training he has at the time of hire to a highway department. From then, by working on his own, he can pick up additional education by study, skill through practice, and know-how through experience. An ambitious employee will do a considerable amount of technical reading as he progresses.

Second, proficiency is obtained by individual efforts of the employee on a planned program of improving his technical perform-

ance. He does this through reading, practice, and consultation. He attends technical meetings, meets individuals, and discusses the technical subjects with them. He may enroll in various educational courses, correspondence courses, or night schools conducted by colleges or local institutions.

The third way to train and educate an employee is through an employer-managed program. This program is the most effective of the three. It can consist largely of the same type program as an individual may follow but under the direction and sponsorship of the employer. The program consists of on-the-job type of rotation but with particular attention given to training individuals to do administrative work. The program will sponsor technical meetings and give every encouragement to employees to attend such meetings. Further, the program should provide for organized courses of study of an academic nature.

These courses can be taught by highway department personnel trained to handle such types of instruction. The classes may be organized through the state college. Correspondence courses can be arranged through a correspondence study institute, by the particular highway department, or standard courses now prevailing may be available. The highway department may set up specialized studies in technical institutes or it may use co-operative types of courses sponsored by the local state college or university.

Four Programs for Training Engineering Employees

The well-organized training program for highway engineering employees would consist of three basic areas. First, a specific plan for training and educating the high school graduate and the drop-out from college. Second, the program would include a specific initial training schedule for the college graduates who are hired by the highway departments. And third, the highway departments would have a specific program for giving refresher courses and courses in scientific and engineering procedures which have been brought about by recent developments and changes in the arts and sciences apropos to a highway department. This program would include not only professional engineers and college graduates but also other engineering personnel.

The highway department should not overlook equal desirability of training administrative, clerical, fiscal, and employees in other occupations.

Training High School Graduates as Technicians[1]

If the highway departments are to achieve a desirable ratio of technicians to professional engineers, they will need a well-designed and definite program for the training of the high school graduate and the college student who drops out of college prior to graduation.

The training and education necessary to achieve an employee ratio of about three technicians to one professional engineer would consist of specific programs in the following five areas: Surveying, drafting, calculations and estimating, inspections, and testing. The training of technicians in these five fields should be primarily a responsibility of the highway department, including the responsibility for financing such training.

The high school graduate could be hired as a general assistant on engineering work. After a short period of employment – say three to six months – his qualifications and abilities to go further in engineering employment could be determined. At that time the high school graduate could be assigned to a formalized training program which might extend over a period of two years.

Accompanying this type of training program, however, should be the establishment of a full-fledged career service in the highway department for a technician. That is, a full line of advancement and specifications for various kinds of positions should be established. The high school graduate or the college drop-out could then see where such employment could eventually lead him.

A career as a technician in a highway department is just as necessary as a career for a professional engineer. On the other hand, up to this time practically no highway department has set out in their employment provisions and in their civil service regulations this specific kind of career.

The training of technicians should combine two generally accepted training schemes. They include on-the-job instruction under a skillful supervisor, and formal classroom or correspondence type of education.

1. See Appendix A for detailed outline.

A high school graduate can pick up the rudiments of surveying in one summer of work. Furthermore, in this one summer of work as a chainman or a rodman his general abilities can be determined together with his interest. If his abilities and interest warrant, he could be referred, particularly in the following winter, to an organized course for instrumentmen. This course could be sponsored by the highway department in co-operation with the state college. Classroom instruction is necessary in order to achieve the theoretical knowledge of surveying and the necessary mathematical skills.

A similar arrangement could be made for the training in engineering drafting, including structural detailing. On the other hand, the necessary skills can be developed in estimating, inspecting and testing, primarily through an organized course taught and managed by the highway department staff.

Program Not of College Calibre

Development of this basic training program for high school graduates should be such that it would encourage them to continue their education eventually obtaining a bachelor of science degree in engineering. Further, the training program can be so designed that with the right amount of home study and practical experience they may ultimately be able to pass examinations for registration as a professional engineer in their home state.

Despite these two objectives of the training program the work given to the high school graduate either through extension courses, correspondence courses, or by enrollment in technical institute courses, should not necessarily be of academic character. The objectives of the two types of training and education are different. While there should be every encouragement for the high school graduate to achieve both college graduation and professional registration, it does not follow that a particular study course would be designed to substitute for college education.

Such types of training and home study that he might do in teaching himself to be a technician, would aid him perhaps in passing certain examinations on college requirements and thus would shorten his period of residential studying on the college campus.

The second basic training program that a highway department should maintain pertains specifically to the civil engineering graduate and his hire immediately upon graduation.

Training Civil Engineering Graduates[2]

Industry as a whole has instituted many excellent training programs for the engineering college graduate. College seniors regard these training programs as one of the vital factors in their decision to accept employment. Such training programs are highly desirable because they furnish the necessary opportunity for the college graduate to gain the necessary practical skill and knowledge of how his education can be applied to the industry into which he has hired. Although these training programs are based primarily on a planned job rotation over a period of one to four years, they can be set up to achieve a certain amount of additional education to classroom or other form of academic study.

The college training permits the graduate to start out on assignments in surveying, drafting, estimating, inspection, and testing at a much higher level than it is possible to start the high school graduate. However, a certain amount of experience in these occupations in a highway department is desirable for the first year of employment of the college graduate. Some highway departments have made the mistake of keeping these college graduates on such assignments for too long. The college graduate no longer expects to make a career out of surveying or drafting.

He expects to get into the more complicated and more important work of design and management for which his college education has qualified him. On the other hand, practically no college graduate objects to these types of assignment during his training period. Such training is desirable because it gives the college graduate an on-the-ground feeling. Further, he has opportunity to pick up the know-how needed later when he will be directing the work of many technicians trained to perform the necessary manipulations and skills required in these areas.

The college graduate training program needs to include a certain period on surveying, design, planning, highway construction,

2. See Appendix B for outline of program.

bridge construction, bridge design, maintenance operations, testing, and work in the materials laboratories. In addition to these manipulative assignments, the college graduate should be given opportunity to learn how general administration manages the over-all performance of the highway department. He needs to work with the office engineer, the chief engineer, and the heads of the various departments in order to determine the importance of the work to these high levels which the college graduate will be performing for his first five to ten years.

Further, the college graduate needs to get practical experience. He should not be confined to one section of the state or one section of the city or to urban work as opposed to rural work.

In some instances his training may have been ended when it was found he was needed in a particular line of work, such as bridge design; or when the individual found what he wanted to do on a permanent basis. The maximum results for training programs of this kind can be achieved only if the college graduate is kept on a full-fledged training program until he has completed every phase of it. At that time, and only at that time, should he be delegated to a permanent type of assignment.

Co-ordination between the various phases of highway department work is essential to the successful operation of the training program. Only by attaining a general knowledge and appreciation of the functions and importance of all department operations can an employee achieve the best results in training and reach a wise selection of the type of work to which he should be assigned at the end of training. The logical time for the employee to gain this knowledge of the widespread activities of the highway department is during this initial training program.

Traffic engineering is singled out as a highly important phase in which the college graduate should get sufficient training. Traffic engineering is not taught in the colleges in any thorough manner since it is only one of the several phases of classroom discussion which comes up in the ordinary course in highway engineering given in most curriculums. Many college graduates, as well as the public in general, do not appreciate the high degree of engineering which is involved in handling and providing for highway traffic.

In general, they think that traffic engineering is the direction of

traffic, the putting up here and there of various highway signs, signals, and markers, not realizing that back of every one of these decisions comes a full-fledged engineering study by personnel highly developed in these skills.

A two- to four-year training program for the civil engineering college graduate hiring out to a highway department is an essential device to accelerate his assimilation into the highway department program. Once he completes this formal training program his advancement as a whole will be rapid and his opportunities for complete development to high level positions will be greatly enhanced.

Training Older Engineer Employees

A third type of training program a highway department should sponsor is one designed for all engineer employees, including those who have completed the training under the technician program and those who have completed the training program for the civil engineering college graduate. In fact, all employees regardless of their stage of engineering education and training up to date are included.

This type of program is desirable for three reasons: (1) Any training of an employee gives an understanding that his employer is interested in him as an individual. It will create a higher level of morale and a definite feeling of belonging to the highway department; (2) such training program is the means by which the technical employees can be brought up to date in engineering practices, and by which new devices, procedures, and instructions can be learned and thoroughly understood; and (3) such types of training programs are highly desirable when major changes are made in highway department procedures. These changes may involve the installation of new types of machines or equipment such as electronic computers, or basically changing standard specifications or other long-established procedures in the highway department.

Training for the engineers in general can be achieved by bringing groups of employees into a headquarters for periods of one day to four weeks. Conference techniques and workshop practice sessions would make up the basic teaching methods. The employees

undertaking this kind of training generally do not care to do much night work or home study. On the other hand, a limited amount of such assignment is desirable because it helps to screen employees really interested from those going for the "ride." In addition, home study develops a greater sense of individual responsibility which every employee should in the end acquire.

An effective training device in this respect is the conduct through the state college or other institutions of an annual highway conference for two to five days. Conferences of this type have the advantage of bringing together the engineers from all over the state including city, county, and state engineers together with a certain number of professional people from outside.

Such highway conferences form an integral part of an adult training program. In addition to the gains achieved through listening to the various technical papers and committee reports, cloakroom and other informal conferences give opportunities for exchange of ideas and arguing out many of the differences of opinion pertaining to technical subjects.

Associated with this third major phase of the training program for highway departments should be included special provisions for the upgrading of engineering employees. Upgrading can be achieved through any process whereby the individual employee can prove his ability to take on higher level work. This accomplishment can be achieved through the encouragement of organized courses at night school, by correspondence courses, and extension courses from the schools of higher learning.

Included also should be specific effort to give employees such training and education as will qualify them to take the state examination for professional engineers. Particularly is this preparation important where professional registration is a requisite for certain types of positions in the highway department, either through state law or through policy of the department.

Non-technical Training

When speaking of the training for engineering employees of a highway department it is easy to keep in mind that the training is in the technical areas. While the greater significance should be in

technical subjects, there are other areas of importance, particularly for the type of employee headed into administrative or high level engineering positions.

Associated with the technical training, a highway department should provide training and education in such areas as report writing, correspondence, effective speech, supervision, administrative technique, and to a certain extent, in public relations.

Instruction in these subjects again can be achieved by organizing special courses to be taught by professional people from educational institutions. Some courses can be taught as night classes. In some cases correspondence or extension type of education can be used.

Furthermore, certain instructional courses could be offered on the employer's time. For selected individuals a good course in correspondence, a good course in effective speech will more than pay its expense when provided on company time.

Scope of Application and Literature

Throughout this article reference is made to "highway departments." All highway departments are included – those of the state, county, city, and special authorities. Although much of what is said is particularly applicable to the state highway department, the principles and specific suggestions can also be applied to other highway organizations including consulting or other private types.

During the last five years many papers and reports have appeared dealing with the training and use of manpower by highway departments. In this article little mention is made of what is going on in highway organizations in this respect. It has been omitted deliberately because the material is available in other sources. Appendix C lists several of the pertinent papers and publications.

APPENDIX A

Objectives: Suggested three-year training program for full time highway employees who have decided not to complete college. Salary is paid during the three years, including short periods of full-time instruction. No academic standards are expected, but if the candidate passes college examinations, and attains college credits, he should be commended.

The purpose of this three-year program, however, is to produce technicians rather than professional engineers. If an employee in this program decides to become a professional engi-

neer, he should be encouraged to transfer from technician training to a co-op training plan which leads to a college degree.

The purpose of this technician program is to prepare men, over a period of three years, to perform the duties of a technician, such as project engineer.

Salary, expenses and cost of instruction to be paid by employer.

Prerequisites for Selection:

1. Graduation from high school
2. Completion of high school course in algebra
3. Passing, with satisfactory mark, a series of tests designed to gauge interest and aptitude for engineering work of technician character
4. Good health
5. Interest in a career as a technician

First Year – June to October: Surveying: On-the-job instruction and rotating to as many surveying tasks as the individual can master. Give him a copy of an elementary book on surveying and encourage him to study it in the evenings and ask questions about surveying.

November – First Two Weeks: Conference room instruction at headquarters eight hours a day. Orientation to highway planning, design, finance, construction, maintenance, and operation. Eighty hours.

Purpose: To acquaint the employee with various broad phases of highway department activity so he can see the relationship between those phases; to have him meet the officials of the highway department, and to show him that this three-year program has the backing of top management in the highway department.

November 15 through March: One hour a day instruction in algebra and trigonometry as related to highway engineering. (Approximately eighty hours instruction plus evening study assignments.)

On-the-job instruction and rotation at headquarters for seven hours a day:

1. Engineering drawing and elementary design — ten weeks
2. Inspection training: soils, concrete, bituminous (conference room instructions at headquarters for seven hours a day) — three weeks
3. Transit and level instruction seven hours a day — two weeks

April-May: On-the-job instruction and rotation in the field, with emphasis on construction techniques:

1. Running a level and transit — one month
2. Inspection of grading and surfacing — one month

Second Year – June through October: On-the-job instruction and rotation in the field on concrete construction:

1. Running a level and transit — two months
2. Inspection of concrete pavement operation — three months

November – First Two Weeks: Conference room instruction at headquarters for eight hours a day:

1. Course in line and grading control leading up to basic principles in location and design:
   a. Surveying principles pertinent to line and grade control — three days
   b. Location principles — three days
   c. Elementary design — four days

November – Third and Fourth Weeks: Conference room instruction at headquarters for seven hours a day:

1. Basic principles of materials — two weeks

December-March: One hour a day instruction in physics for eight weeks and one hour a day in chemistry for the next eight weeks, both relating to highway engineering. (Approximately eighty hours of instruction plus evening study assignments.) On-the-job instruction and

rotation at headquarters seven hours a day:

1. Materials laboratory — one month
2. Reading of plans — one month
3. Engineering computations — one month
4. Estimating experience — one month

April-May: On-the-job instruction and rotation in the field, with emphasis on bituminous pavement:

1. Running a level and transit — one month
2. Inspection of grading and surfacing — one month

Third Year – June through October: On-the-job instruction and rotation in the field on bituminous construction:

1. Running a level and transit — two months
2. Inspection of grading and surfacing — three months

November – First Two Weeks: Conference room instruction at headquarters for eight hours a day:

1. How to supervise employees — one week
2. Techniques of self-improvement — one day
3. Public relations — four days

November 15-March: Full time individual instruction in principles of design for one week.

Assignment to a design engineer as his assistant for one month.

Responsibility for a simple design project for three months.

Evening Instruction: 1. Effective speaking one hour a week for sixteen weeks; 2. Report writing one hour a week for sixteen weeks; 3. Reading improvement two hours a week for sixteen weeks.

These courses can be scheduled with the assistance of a state college or through the help of the state adult education service or its public service institute.

April-May: Full responsibility for a particular task, such as: all inspection at bituminous plant; all responsibility for running compaction tests; or responsibility for inspecting each concrete pour. Eight weeks.

APPENDIX B

Outline of Training Program for Civil Engineering Graduates

Objectives: The objectives of a formal training program for civil engineering college graduates are to:

1. Afford the graduate opportunity to become acquainted with all phases of the operations of a highway department.
2. Permit him to learn the applications of the theory and principles he learned in college.
3. Teach him the particular procedures, policies, and standards of the particular highway department.
4. To permit him a specific training period in which to gain confidence and know-how before assuming full responsibility for professional work.

Specific Phases of Training: The outline which follows is in a time sequence based on summer field assignments and winter office or headquarters assignments. Certain assignments would be undertaken simultaneously by breaking up the day or week.

First Summer (June to October): Survey party on highway and bridge locations; also earthwork and drainage construction contracts — five months

First Winter (November to March): Overall orientation at headquarters (one week); highway design and preparation of plans; materials testing, and specifications and contracts: five months

Second Summer (April to October): Concrete and bituminous paving construction engineering and inspection — seven months

Second Winter (November to March): Bridge design — five months

Third Summer (April to October): Bridge construction and inspection — seven months

Third Winter (November to March): highway planning (one month); right-of-way (one month); materials laboratory (one month); traffic engineering (one month); highway maintenance (one month) — five months

Total — thirty-four months

APPENDIX C
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Are We Over-Emphasizing Speed As an Accident Cause?

ROGER G. STEWART

Dr. Stewart is a Research Psychologist in the Institute of Transportation and Traffic Engineering of the University of California. During 1951–53, he was a Research Associate in Psychology in the University of Illinois. He is author and co-author of papers on psychological characteristics of habitual traffic violators and other drivers. He is a member of the American Psychological Association and the Western Psychological Association.

CONSIDERABLE emphasis is directed today toward fast driving and speeding as a major cause of automobile accidents. Two factors are primarily responsible, in the writer's opinion, for this emphasis: (a) a knowledge of certain statistics that seem to show that speed violations are frequently involved in automobile accidents; (b) a desire by safety officials and other interested individuals to find a satisfactory and feasible solution for the nationwide problem of accidents. Of course, the greater number of licensed drivers, increase in speed and performance of modern automobiles, and improvements in major highway design and quality are other factors associated with recent publicity regarding speed as a nationwide problem.

During 1955–56, considerable data bearing on this problem were collected for a sample of 346 students in the University of California, Los Angeles.[1] These subjects, for the most part, had been driving in California for two years or more, prior to 1955. The median age for the group of 224 men and 122 women was about twenty-one years.

Certain facts concerning these students were obtained from two broad sources: (a) a driving inventory on personal driving habits and experiences; (b) the official traffic records supplied by

1. The author is grateful for the contributions and assistance of the following individuals during this study: Dr. Harry W. Case, Department of Engineering, University of California, Los Angeles; Mr. Paul Mason, Director, and Mr. Fred P. Williams, Chief of Division of Drivers Licenses, Department of Motor Vehicles, State of California; Dr. T. H. Southard and Mr. F. H. Hollander, Numerical Analysis Research, Department of Mathematics, University of California, Los Angeles.

the Department of Motor Vehicles in Sacramento. From the inventory, four items concerning driving speeds were used for classifying the subjects in terms of speed. These questions were asked on the inventory:

What is your usual highway driving speed (mph) during daylight?

What is the fastest speed (mph) you have ever driven any car on a highway?

Recall the last time you made a long automobile trip. On the highway, what speed (mph) did you drive at most frequently?

What is your usual highway driving speed (mph) at night?

From the official traffic records, frequency counts based on the last two-year period were obtained for the following variables: speeding citations, total traffic citations, and accidents. Using the four speed variables from the inventory and these three traffic variables from the official records, some analyses of possible relationships between variables were made using the statistical technique known as *chi square*.

The results show that speed is somewhat related to a record of speeding citations and total traffic citations, but seems independent of a record of one or more previous accidents. Based on simple speed groupings, the chi squares with their corresponding contingency correlation coefficients are shown in Table 1.

Table I

CHI SQUARES AND CONTINGENCY COEFFICIENTS FOR SPEED ITEMS IN RELATION TO SPEEDING CITATIONS, TOTAL CITATIONS AND ACCIDENTS

	(*Contingency Coefficients in Parenthesis*)		
Speed Item	*Speeding Citations*	*Total Citations*	*Accidents*
Daylight Speed	12.09 (.18)*	27.23 (.27)*	1.02 (.05)
Night Speed	18.85 (.23)*	20.72 (.24)*	.31 (.03)
Recent Trip Speed	10.48 (.17)*	16.53 (.22)*	.40 (.03)
Fastest Speed	22.87 (.25)*	36.66 (.31)*	3.95 (.11)

**Chi square significant at the .01 level.*

The significant chi squares, shown in Table 1, mean that there was a lack of independence between the students' responses to the four speed items and previous records of speeding citations and total traffic citations. In each instance, those who reported faster

driving speeds had more frequently received one of the citations than those who reported slower speeds. The correlation coefficients, however, suggest that the degree of relationship is rather low. With such coefficients, one could scarcely use responses to the speed items to tell which subjects had received one of the citations during the last two years. Certain implications of these findings will be discussed later.

Table 1 presents no evidence that the subjects who reported faster driving speeds had more often been involved in automobile accidents. The four chi squares regarding accidents are well within the limits of chance. Since the four speed variables are inventory items, rather than some measure of actual driving behavior, it is conceivable that some other kind of speed variable would show evidence of a relationship between tendencies toward fast driving speed and involvement in one or more previous accidents.

With speeding citations and total traffic citations as independent criteria of driving behavior, the 346 students were classified regarding previous accidents. In each case, the chi squares were within the limits of chance. The contingency table for speeding citations and accidents is shown as follows:

Table II

RELATIONSHIP OF INDIVIDUALS WITH SPEEDING CITATIONS AND ACCIDENTS

(*Expected Frequencies in Parentheses*)

	No Accidents	*Accidents*	*Total*
Speeding Citations	52 (56.8)	18 (13.2)	70
No Speeding Citations	229 (224.2)	47 (51.8)	276
Total	281	65	346

$X^2 = 2.70$ (*not significant at the .05 level*).

Table 2 shows that a somewhat greater proportion of subjects with one or more speeding citations had been involved in an accident than the non-violators, but this result is within the limits of chance.

The item about recent long trip was considered in relation to the *prima facie* speed limit of fifty-five miles an hour in California. Of the 332 students responding to this query, 210 reported a typical

highway driving speed on their most recent long trip in excess of fifty-five miles an hour. In other words, these drivers were "eligible" for a speeding citation during their trip. These students were compared with the 122 individuals who reported speeds consistent with the state speed limit in terms of the citations and accidents. The chi squares obtained from these comparisons were almost identical with those shown in Table 1 for this speed item.

In addition to this speed analysis as to citations and accidents, the 346 students were classified into five subgroups with regard to the median speeds of the four item distributions. One might assume that an individual who reported a faster driving speed than the median speed under each of several conditions would differ in certain respects from an individual who consistently reported a slower than the median driving speed for the given traffic condition. Of the 330 individuals who responded to all four speed items, sixty-five reported a speed below the median of each item distribution. These might be called the extremely slow drivers of the total sample. On the other hand, seventy-three drivers reported a speed above the median of each distribution – the extremely fast drivers of the sample.

Table 3 shows the number of subjects in each of the five median subgroups, and the percentage of subjects in each subgroup with one or more speeding citations, total traffic citations, and accidents.

Table III

NUMBER OF INDIVIDUALS WITH SPEEDING CITATIONS, TOTAL CITATIONS, AND ACCIDENTS IN MEDIAN SUBGROUPS

Median Subgroup (*No. Times Above Median*)	*N*	*Speeding Citations*	*Total Citations*	*Accidents*
Zero	65	4 (6%)	12 (18%)	12 (18%)
One	69	10 (14%)	17 (25%)	11 (16%)
Two	57	8 (14%)	21 (37%)	14 (25%)
Three	66	19 (29%)	35 (53%)	11 (17%)
Four	73	28 (38%)	43 (59%)	15 (21%)
Total*	330	69	128	63

*Number of subjects who responded to all four speed items.

The percentages for the two citation categories, as shown in Table 3, tend to support the findings presented in Table 1. The

percentages tend to increase progressively from the slow-driving to the fast-driving median subgroup. By comparing the two extreme subgroups, we find that the probability of having received one of the citations is much higher (.38 vs. .06 and .59 vs. .18) for individuals in the extremely fast subgroup than for those in the extremely slow subgroup. Concerning accidents, Table 3 shows that the five median subgroups contain almost equal percentages of individuals with one or more accidents.

Statistics and Study Results Compared

Our results seem to mean that driving speeds on the open highway for these students, based on inventory responses, have low correlations with records of speeding citations and total traffic citations. The results fail to provide evidence, however, that involvement in previous accidents was related to reported speeds on the open highway for these drivers. When the individuals were classified as violators vs. non-violators for speeding offenses and total traffic offenses, similar results with regard to accidents were obtained. Therefore, within this sample of university students, one could not pick those subjects with one or more recent accidents from a knowledge of their reported driving speeds, their speeding citations, or their total traffic citations.

When our results are compared with those widely publicized by some traffic authorities, certain questions arise. To illustrate, the most recent edition of *Accident Facts*,[2] states that excessive speed was the most important driver-violation in fatal accidents during the previous year (1955) for both urban and rural areas. The importance of speed as a contributing circumstance in accidents was summarized, in part, as follows:

"About three out of ten drivers in fatal accidents were violating a speed law, according to reports from twenty-one states. Specifically, violations were reported for 31 percent of the drivers (17 percent were exceeding stated speed limits, and 14 percent were exceeding safe speeds although traveling at less than the stated speed limits or on roads where no stated limits existed).

2. *Accident Facts*. National Safety Council, Chicago. 1956.

"These speed violations were factors in 37 percent of the fatal accidents, even though only 31 percent of the drivers were violating. In some two-vehicle accidents only one driver was speeding, so speed was reported for a higher percentage of accidents than of drivers."

How should these statistics be interpreted? And in the light of them, how should our findings be interpreted? The fact that statistics involve large numbers is not proof of high reliability, of course, unless certain precautions have been observed. Concerning the quoted statistics, the following questions might be asked:

1. Do reporting states have the same type of speed limit (reasonable and proper, prima facie, absolute)? By definition, driving behavior that constitutes a legal speeding violation varies among the forty-eight states. Enforcement of speed laws is conditioned, in part, by the type of speed limit prevailing throughout a state.

2. Do reporting states with specified limits have the same numerical speed limits? For instance, some of the states have two speed limits, one for daylight and another for night driving.

3. Do reporting states have the same rules for reporting vehicle accidents? While considerable uniformity may exist with respect to fatal accidents, there is much variation among the states concerning accidents that involve only personal injuries and/or property damage.

In view of numerous combinations of conditions under which one or more drivers in a given accident might be reported for a speeding violation, it may be questioned whether these mass statistics reflect the relation of speed to accidents in any one of the twenty-one reporting states, or in the states that failed to report. Since the mass statistics may or may not represent conditions throughout the United States as a whole, it is understandable that certain research findings based on a fairly homogeneous sample of drivers within one state might be at variance with mass statistics compiled from many states.

Further statistics shown in *Accident Facts* suggest an interpretation of our results. Figures based on reports from nineteen states show the approximate speed of vehicles involved in fatal accidents during 1955, with the following percentages of vehicles in four speed ranges: 0–20 mph, 17 percent; 21–40 mph, 30 percent;

41–60 mph, 35 percent; 61 mph and over, 18 percent. For this kind of data, as well as for speed violations involved in fatal accidents, it is difficult to obtain correct information.

Nevertheless, the percentages show that most vehicles involved in fatal accidents during 1955 were not reported moving at excessive speeds. In fact, the distribution of vehicle speeds shown above may be very similar to vehicle speeds prevailing on most highways under normal conditions. Perhaps this fact means that the speed violations reported in fatal accidents were more commonly associated with low or moderate, rather than high, vehicle speeds on our roads. To this extent, therefore, the subjects of our sample who reported high speeds should be expected to show no more involvement in accidents than those who reported moderate or low speeds.

In conclusion, our results suggest that individuals in the kind of population considered who report consistently higher driving speeds than average have, in reality, traffic records free of accidents as often as other drivers. This finding also seems to hold for individuals with previous speeding citations and all traffic citations. If these results should be verified for drivers in the general public, it would be well to re-examine certain emphases and enforcement procedures based on the belief that fast drivers become involved in accidents proportionately more often than medium-speed, or slow drivers.

Old Roads

MAXWELL N. HALSEY

Mr. Halsey has been Traffic and Safety Advisor on the full-time staff of the Eno Foundation since 1956. For fourteen years prior to that, he was Administrative Head of the Michigan State Safety Commission. Previously he was Associate Director of the Yale Traffic Bureau, following two years as Assistant Director of the Harvard Bureau for Street Traffic Research. He organized the first traffic engineering division of the State of Massachusetts. He was the founder and a charter member of the Institute of Traffic Engineers. Mr. Halsey is the author of three books: "Traffic Accidents and Congestion"; "State Traffic Safety", and "Let's Drive Right."

CONGRESSIONAL appropriation of thirteen billion dollars in 1956 placed deserved emphasis on the interstate and major state highways of this country – a logical priority for roads that will carry our heaviest traffic. This emphasis diverts some engineering attention from many other streets and roadways that form an essential part of the national free-wheel vehicle roadbed. If the effect is to make great improvements on the new roads but de-emphasize old roads, the total system will be out of balance. This situation would become more critical as traffic volumes increase. It is important at the outset of an era of building tremendous new roads that parallel attention be directed to existing roads.

The new-road old-road traffic volume stituations can be visualized from the following figures:[1]

A. 40,000 miles ninety percent federal (interstate system, rural and urban) aid roads will carry 14.2 percent of the nation's vehicle miles.

B. 192,506 miles of fifty percent federal aid primary roads will carry 32.2 percent of nation's vehicle miles. In addition, federal aid secondary roads under state control total 146,264 miles and seven percent of the nation's vehicle miles.

C. 24,702 miles of state non-federal aid highways will carry 1.4 percent of the nation's vehicle miles.

D. 307,791 miles of federal aid secondary roads under local

1. 1953 Highway Needs Study Public Roads Administration.

control will carry 5.8 percent of nation's vehicle miles. In addition, all other rural local roads total 2,332,950 miles and 11.6 percent of the nation's vehicle miles.

E. 340,199 miles of city streets (not included in the interstate or federal aid primary system) will carry 27.8 percent of nation's vehicle miles.

F. 686,561 miles of federal aid highways will carry 59.2 percent of national vehicle miles but this leaves 2,697,851 of non-federal aid highways and city streets that will carry 40.8 percent of national vehicle miles. (See Table I.) These figures will be changed some, since the interstate mileage has been increased to 41,000 and is estimated to carry 20 percent of the nation's vehicle miles – 603,434 million in 1955 but this continues to indicate that old roads do represent a substantial problem.

Traffic on old roads and streets not directly affected by federal aid will ultimately have to carry more traffic than at present – partly because of estimates of increased annual traffic, and in other instances because of the encouragement of travel produced by the new superhighways. These may temporarily draw traffic from old highways and streets, but over the years the travel on old facilities will far exceed the present volume.

TABLE I

SHOWING MILES OF ROADWAY AND PERCENTAGE OF VEHICLE MILES OF TRAVEL

Based on 1953 *Highway Needs Study*

FEDERAL-AID ROADS			*NON* FEDERAL-AID ROADS		
Type	*Miles of Road*	*Percent of Travel*	*Type*	*Miles of Road*	*Percent of Travel*
Interstate	40,000	14.2	State	24,702	1.4
Primary (State)	192,506	32.2	Local Rural		
Secondary (State)	146,264	7.0	(*not* state)	2,332,950	11.6
Secondary (Local,			City Streets	340,199	27.8
not state)	307,791	5.8			
Total	686,561	59.2	Total	2,697,851	40.8

SIGNIFICANCE REGARDING EXISTING OR OLD ROAD PROBLEM

1. 2,697,751 miles of roadway will receive *no* federal-aid – of these 2,357,652 are highways and 340,199 are city streets.

2. 40.8 percent of the total vehicle miles of travel will be on *non*-federal-aid roads – of this, 12 percent will be on highways and 27.8 percent will be on city streets.

In effect, the federal-aid program will improve only one-third of the miles of roadway and only 59.2 percent of the total vehicle miles of travel. This leaves the States, Counties and Cities with two-third of the miles of roadway and 40.8 percent of the miles of travel on which to try to make a substantial improvement.

New Jersey State Highway Department officials are reported as saying: "In many cases, traffic has decreased on by-passed roads and then gradually increased until previous traffic was either equalled or surpassed." Ralph L. Fisher, assistant supervising engineer of the New Jersey Highway Department, states in his article, "Designing for High Capacity":[2] "As an example, let us suppose that the opening of a new route reduces traffic on the old route by twenty-five percent. If the annual average increase in traffic in the area is five percent a year, the relief would last only five years. This means that the older-route problems are back again and, with yearly increases in traffic, become more critical each year. In some cases, new construction thus only briefly defers needed improvements to an older route.

An increasingly common practice is to spend considerable sums of money to increase the capacity or safety of an older route.

It has been reliably stated that up to eighty-five percent of the interstate system will be built in new locations. Thus, of 41,000 miles to be built, 34,850 miles would not follow the old right-of-way, and that mileage of the old road would remain.

New federal aid highways will be built to higher standards than most present roads and on new highways, accidents and congestion will be much less. It has been estimated that the new roads will save lives at the rate of 3500 a year.

In one sense, building safer, less time-consuming *new* roads will transfer some congestion and accidents to the old. Safety gains on the new might be offset by losses on the old. A realistic attack on the nation's accident and congestion problem should contemplate a substantial improvement in old roadways as new facilities are built.

Focusing attention on old roadway improvement is difficult for many reasons:

1. Financial problems. A state's raising funds to match the increased federal aid may reduce funds available for non-federal aid roads.

2. Counties and cities without federal aid, except on expressways, needing to raise more funds, may find it difficult to obtain an adequate increase.

3. Psychologically, new roads are stimulating; old roads are

2. *Traffic Quarterly*, April, 1957.

discouraging. Most engineers prefer to work on something new, rather than to renovate an outmoded facility.

4. Some old roads may be viewed as replaced by proposed new facilities. Yet unless actually removed the old will produce heavy congestion as volume increases, and, even with relatively light volume, may continue to add to traffic fatalities.

This reasoning suggests there is a strong need for a fifteen-year program for improving old roads as a companion piece to the fifteen-year new road program. It would not seem reasonable to leave the old road problem to work itself out with no basic plan. Because many old roadways are at a low engineering control standard level, relatively modest expenditures could in many cases produce excellent results.

Aside from directing engineering improvements against accidents and congestion, there is the goal of bringing control devices up to minimum standards. While this in itself might not bring substantial measurable cuts in accidents and congestion, it would improve the operating climate, thus permitting improvements to contribute more effectively. It is time to determine the cost of raising equipment to higher standards to establish a long-range budget.

Types of Old Roads

To discuss old roads, it is necessary to put them in focus with regard to main elements of the total system. Major classifications are the interstate system, state primary roads, state secondary roads, county highways, and city and community streets. The greatest impact of the Federal program on a ninety-ten matching ratio will be on the interstate system. The fifty-fifty matching basis will reach state primary and secondary roads. Another basic impact will be in regard to expressways in cities. The new national program does not specifically provide for substantial additional parallel sums for either county roads or city streets.

Another type of classification might be old or existing roadways to be brought up to reasonable standards in their present locations compared with existing routes to be by-passed with new facilities on new rights-of-ways.

If highways and expressways of present maximum standards can be regarded as the system's backbone, roads and streets re-

maining might be thought of as feeders and distributors. In such capacity they are of real importance.

Some existing roads can be grouped as (1) those reasonably close to, and connected with, the super-roadways and therefore in need of higher standards to reduce the shock of going from an excellent roadway to a mediocre one; (2) those to be by-passed but not abandoned or closed off, perpetuating their shortcomings; (3) roads farther down the scale will gain no financial benefit from the new federal moneys, and (4) existing city streets that receive no federal aid. It can be argued that if states receive increased federal money, it will relieve state money for counties and cities. On the other hand, the need for relief from congestion and accidents in terms of the low functional level of both city streets and county roads, coupled with mushrooming problems to be brought on by increased traffic, suggests that their problems may increase at a faster rate than added income. Some states may be hard pressed to match federal funds and may not regard it advisable to give more financial aid to counties and communities. Thus their needs, as a part of the total road net, should be emphasized at this time.

The Broad Perspective

Old roads and the existing roads, as discussed in this article, include city streets, by-passed old highways, state and county roads not aided financially by the new federal program, and those to be upgraded in their present locations. In these groups the need for upgrading and the difficulty of achievement is enormous compared to building a new highway or expressway facility to high geometric standards in a location where no roadway of any importance existed before.

The proposition of grading America's roadways is a gigantic concept. The federal government has logically selected the interstate system for major consideration with geometric standards as high as many of the best existing roadways. Then by substantially increasing the amounts of federal aid for primary and secondary roads in states, it can be assumed that state highways not on the interstate system will also be upgraded but not necessarily to the same degree as the interstate roadways. It is hoped that states will

make a determined effort to keep geometric designs on heavily traveled high-speed routes up to the interstate levels, since many of these will carry heavy volumes. Thus far in this sequence there should be optimism about high geometric designs for heavy volume highways under federal and state control.

When state roadways, expected to carry volumes not warranting four-lane divided grade-separated geometric design, are considered – many of them existing highways or old roads – the question arises as to whether the upgrading of elements other than medial dividers and grade separations will be in the same order of magnitude as the advance to medial dividers and grade separations. Certainly the advance to limited access and medial dividers plus acceleration and deceleration lanes represents an improvement over previous heavy-volume high-speed roadways.

To match this rate of gain, functional values of traffic signals and critical signing should be comparably improved. Similarly this reasoning applies to edges of old roadways, markings, reflectorization and lighting. In most instances, engineers know how to do this. Whether they do or not will be resolved by philosophical and administrative considerations. It is logical that billions for major routes should be reasonably matched by funds to upgrade old roadways. Assuming that state highway departments recognize this dilemma, the next stage in the sequence of a balanced America-wide program would be the counties.

Everyone is familiar with the development of traffic on overcrowded state highways spilling over onto county roads, especially metropolitan areas. This places greater loads on county highway engineering departments. It is true that they receive state aid, but it is problematical as to what consideration counties will receive.

When the federal gasoline tax was increased one cent a gallon, this, theoretically, should have been matched by the states' increasing their gasoline tax one cent a gallon to give the states the proportionally same amount of funds to pass on to counties and cities in the form of state aid. In most cases, this has not happened. As a result, it can be said that, money-wise, state-gains at the moment will exceed those of county and city.

To approach the rate of gain of federal and state highways, it is apparent that both counties and cities will have to obtain an

increase in their own funds – or face a rate of improvement that will fall below that of states. This provides a difficult taxation problem.

The last link is the cities where we have maximum congestion and accidents (not fatalities). To match the national gain on interstate, primary, and secondary state highways, the cities would have to increase their funds for traffic improvements. They will receive federal and state aid, but this will be largely restricted to expressway connections with interstate and state primary roads. It will not contribute financially to the central business district street system or to arterial streets, to say nothing of their business and residential streets. In dollars they would have to double their budget for traffic movement expenditures, in addition to funds for parking facilities. If this is not done, one may logically predict that the country will be presented with a worse situation than most cities face.

This sequence from the interstate system to state primary and secondary highways to county highways to city streets shows the broad spread of facilities that should be taken into account if we are to have a balanced solution through the long period leading to the completion of present plans.

County Old Road Problems

Predicted increases in traffic volumes indicate that many county highway departments will face special problems. Increasingly, motorists may move from crowded state highways to county highways with less traffic – sometimes a more direct route. To this increased volume may be added more traffic from city residents moved to the country and the attractions of shopping centers. It is difficult to take account of these factors in regular estimation, but they should be considered over and above regular normal traffic growth.

Since they have less money than state highway departments have, county officials have been unable to build full safety into their roadways. There is the common example of newly paved old roads, without a painted center line to assist motorists who drive faster on smooth pavement. Many lack clear signs, enough "no-passing"

zones, and reflectorized modern signals. Due to more economic limitations and less enforcement than for state highways the automobile fatality problem in some states is greatest on county roads.

The simple mathematics of more cars points up the necessity of lifting the geometric design of two-lane county roads to the same safety level as modern geometric design for two-lane state highways. In some instances the justification will have to be exclusively on safety. A motorist should not have his safety substantially reduced, because he drives from a four-lane highway to a two-lane highway.

Downtown Congestion

The interstate system with a geometric design aimed at safe speeds in the ranges of sixty to seventy miles an hour lifts the rate of movement ten to twenty miles above the best old-style highways. If the delay at grade crossings is considered, the new roads should show an appreciable gain in running-time of from forty to fifty percent.

The expressway counterpart in cities will at least double the city street speeds of twenty to twenty-five miles an hour – ten to fifteen in peak hours. Yet the expressways will carry only a part of the total intra-city travel. This leaves the majority of city streets with congestion problems that become more critical as volumes increase – volumes stimulated by expressways that attract more shoppers to the central business district – if they can find a place to park.

What upgrading of city streets can be arranged comparable to the upgrading planned for interstate highways? And how can necessary budgets be obtained?

While it is true that lifting a rate of movement from ten to twenty miles an hour, or from fifteen to thirty miles an hour would represent doubling the convenience factor, such an increase is exceedingly difficult in some areas. Certainly the new highway program should stimulate a fifteen-year upgrading program for city streets.

Among the engineering approaches capable of producing a high rate of gain in cities are:

1. Building sufficient off-street parking facilities to make it feasible to prohibit parking and make partial use of additional lanes available.

2. A broader application of one-way streets.

3. Treating arteries with several restrictive techniques to eliminate most direct conflicts through one-way blocks away from them, no left turns, right turns only and blocking off unimportant streets, thus in effect limiting access to signalized intersections.

4. The use of unbalanced flow.

5. Installing the most modern electronically controlled signal equipment which constantly adjusts its timing to minute-by-minute changes in traffic.

6. Placing motorist signals over moving lanes and separate pedestrian signals at the rear of crosswalks.

Such items run into high costs, but spread over a period of fifteen years, they should prove their worth. Some cities, recently doubling their budgets, are thinking in terms of substantial gains rather than of minor improvements. All cities, after careful study, should advance their thinking to include their own fifteen-year traffic-improvement programs to keep pace with highway development.

Upgrading Control Items

Advances in geometric design have been so great as to overshadow the potential upgrading of other engineering control items. Those in the traffic field think today of a two-lane highway without grade separations, limited access, and naturally not a medial divider, with modern geometric design that will cost twice as much as they would have thought of a few years ago. Yet because of the emphasis on geometric design, engineers have given less attention to spending more for an advanced model of traffic signal installation – well worth the increased cost. Nor have all engineers totally accepted the idea that an important sign suspended over the moving lane – more costly than a sign on the shoulder – may be a good *investment*. The thinking on access-control has, to some extent, been directed to new construction. Yet there are well-known engineering methods of improving the access-situation on *old* roads. Equipment available can double the effectiveness of signs, signals, markings, islands, and access-control, if engineers are willing to increase expenditures for them, as they are willing to double expenditures for a new two-lane highway.

"Twice as good" traffic control equipment, access-control, and collateral items are the chief hope of upgrading old roads to bring

their rate of improvement close to matching the rate of gain in geometric design in the interstate system already arranged for.

Classifications of Traffic Elements

In undertaking to prepare a long-range program for attacking the movement and safety aspects of old roadways, it is essential to have clearly in mind the wide range of possibilities in the application of mobility items. It may be helpful to group these items into the following eight categories:

A. Construction
B. Control Equipment
C. Regulation
D. Intersections
E. Built-in areas
F. Open country
G. Higher expenditures
H. Public support intensity

This classification results in some overlap but the groupings may serve as a useful check list.

A. Construction Items: These under the broad category of construction are "movement" items which, while they represent actual construction, have the characteristic of being aimed primarily at the mobility function rather than being treated from the structural support or maintenance characteristic aspect. While all construction is naturally aimed at carrying traffic – moving it – these items listed can be brought to bear as remedial measures. Put another way, they represent a screening of all construction items to select those having an unusually strong bearing on movement and safety. Many of them also fit the category of geometric design.

These are typical:

1. Adding Medial Dividers
2. Widening Lanes
3. Installing Channelizing Island
4. Intersection Re-design
5. Adding truck or passing lanes on hills and curves

6. Removal of fixed obstructions
7. Adding or widening shoulders for recovery areas
8. Installation of barrier islands for roadside business entrances
9. Moving earth and vegetation to open up blind corners
10. Re-surfacing slippery pavement
11. Adding acceleration of deceleration lanes
12. Additional lanes for left and right turns
13. Adding pedestrian sidewalks
14. Adding grade separations

B. Equipment Items: These are engineering items usually referred to within the category of traffic control devices. If the highway is thought of as a total facility for safe and convenient movement of persons and merchandise, equipment items are as important a part as construction items. When contemplating the building of a highway or converting old highways, all traffic control devices should be installed simultaneously with all other construction items. In estimating the cost of a facility, the cost of control devices should be an integral part of the estimate. It may well be that in the long run many of these items will be included in the contract for the construction of a highway. The following are examples:

1. Improved or additional traffic signals.
2. Application of guard rail, for insulation, as well as holding vehicle on the road.
3. Highway lighting – intersection lighting.
4. Delineators and reflectorization.
5. Vastly improved signing such as signing over moving lanes.
6. Reflectorized paint lines – pavement edge lines.
7. Radar control installations.
8. Safe speed curve, hill signs, and signalized intersection signs.

C. Regulation Items: Statutes, ordinances, and signs affecting movement of vehicles are essential parts of a traffic facility. It is illogical to plan an overall improvement of an old road without improving also the specific regulatory aids.

Rules can reduce conflicting movements to a point where the roadway facility approximates a limited access roadway. Such rules can eliminate most direct crossings except at spaced-out

access-intersections controlled by full, flexible signals. This involves such techniques as:

1. Physically blocking off very unimportant area streets.
2. Eliminating conflicts at less important streets by permitting right turns by vehicles coming from such streets.
3. Eliminating conflicts at unimportant cross streets by making each leg a one-way street away from the artery.
4. Eliminating left turns except at the access intersections controlled by signals.
5. Prohibiting parking or stopping.

The following are the more common regulations:

1. No left turn
2. No right turn.
3. Right turn only.
4. No parking.
5. No stopping.
6. Speed zoning.
7. No passing.
8. One-way streets.
9. Stop signs.
10. Yield right-of-way signs.
11. Variable speed limit signs.
12. Special snow – ice – fog intermittent signs.
13. Blocking unimportant streets.
14. Reversible lanes

D. Intersection Items: Increases in either speed or volume on old roads are likely to cause increased problems at intersections. If volume decreases, perhaps temporarily, on an old road because of being bypassed by a new highway, there may well be an increase in common speed.

When volume becomes greater, the left-turn conflicts are magnified; the increased traffic can no longer be cared for by existing lanes entering the intersection. The *infrequent* conflict becomes *frequent* and as more paths of moving vehicles cross, the increase in exposure is certain to bring with it more accidents and congestion unless advance steps are taken.

The potential redistribution of traffic from a new roadway will

in many cases concentrate additional volumes on old roads barely able to handle their present volumes with acceptable levels of delay and collision.

Thus in planning a long-range program for the improvement of old roads, special attention should be given to making marked improvements at intersections:

1. *Total* paint line application.
2. Traffic signal improvements.
    a. Actuated, time clock equipment, full electronic automatic timing.
    b. Improved location of signal faces – over moving lanes.
    c. Duplicate faces.
    d. Special pedestrian "wait-walk" signals.
    e. Larger red lenses.
    f. Paint housings yellow.
    g. Background target to shield from neon signs.
    h. Separate signals for separate lanes.
3. Increase radius for turning movements.
4. Widen for additional lanes for turning.
5. Accelerating and decelerating lanes.
6. Street lighting.
7. Where more than four entering streets make one a one-way street away from intersection.
8. Reduce intersection conflict by no turns on main street and right turns only on cross street.
9. Eliminate intersection by making both cross streets one-way streets away from the intersection or by barricading unimportant cross streets.
10. Install sidewalks and curbs.
11. Move parking back from intersection.
12. Create right side left loop for left turns (jug handles).
13. Use pedestrian fence to block dangerous movement.
14. Use two one-way streets to simplify control.
15. Eliminate confusion in destination signs.

E. Built-Up Area Items: Along many old roads, roadside businesses have developed in a continuous line. In attacking that situation, techniques that have special application can collectively give a

built-up strip a different appearance and vastly superior operating climate. To apply enough techniques simultaneously on an undesirable situation requires imagination and determination. Examples are:

1. Speed zoning.
2. No-passing center lines and lane lines.
3. Reducing unlimited access to points of entrance and exit.
4. Use of buffer island or guard rail to delineate access points and move parking away from moving lanes.
5. Narrow medial dividers to separate traffic, prevent "U" turns and left turns, and prevent mid-block pedestrian crossing.
6. Development of parking lots at rear of stores.
7. Minor street widening to obtain adequate lane widths and permit narrow medial divider.
8. Paving shoulders and installing curbs.
9. Sidewalks.
10. Street lighting.

F. Open-Country Highway Items: In sharp contrast to the built-up areas on old roads are open-country stretches of old highways built years ago to standards that today would not be considered. In many cases, the situation has been aggravated by later provision of a smooth surface inviting higher speed and failing to take engineering steps to make the higher speed at least as safe as previously. Items listed are a number of types of techniques that could be applied to improve conditions:

1. Speed zoning.
2. Curve speed signs.
3. Hill speed zones.
4. Reduced speeds at signalized intersections.
5. No passing zones.
6. Minor pavement widening to obtain adequate lanes.
7. Extra lanes on blind hills and curves.
8. Cutting back vegetation to increase sight distance.
9. Improving shoulders.
10. Reflectorized paint lines.
11. Pavement edge lines.
12. Supersized signs at points of special hazard.
13. Progressive use of actuated traffic signals for speed control.
14. Widening of key intersection for left turns.
15. Reflectorized delineators.

G. Higher Than Average Expenditure Items: To budget for improving an old road, it is helpful to visualize items in the higher cost bracket. Engineers are familiar with the cost of regular construction items most closely related to traffic techniques.

Today those concerned with constructing new highways are thinking of geometric standards that have been upgraded from earlier designs. The rate of upgrading should be matched by equal improvement in the field of traffic control equipment. Thus in improving an old highway, we should think in terms of important signs and signals being mounted over moving lanes. In particular cases, consideration should be given to illuminated signs with changeable messages. Signals should not be restricted by outdated minimum standards; they should use timing devices of maximum flexibility. The increased cost of superior equipment would not represent a higher percentage of the cost of a new superior highway compared with the cost percentage of average equipment for an old facility.

Examples:

1. Construction engineering items.
2. Highway lighting.
3. Modern traffic signals.
4. Radar control.
5. Supersized signs suspended over lanes.
6. Convertible signs for fog, snow, ice.

H. Public Support Items: In developing a master plan for improving the traffic of an intensely built-up area along an old highway, special consideration should be given to items in the sensitive area of public support. Special plans should be made to present them to the local representatives and explain them sufficiently to obtain their support. In cases of restrictive items, it may be difficult because many will magnify the minor inconveniences and fail to visualize the major gains.

Examples:

1. Restricting access of roadside business or minor crossroads.
2. Prohibited turns or right turn only.
3. Prohibited parking or stopping.

4. One-way highways or streets.
5. Requiring parking lots for roadside businesses.
6. Medial dividers that block left turns into driveways.
7. Barrier islands at entrances to roadside business.
8. Eighty-five percentile speed zoning.

The End Product

If a total program of improving all roadways in America can be achieved, the outcome from the point of view of the motorist might be as follows:

A traveler leaves his home at twenty-five to thirty miles an hour and proceeds to the nearest artery protected by stop-signs and traffic signals of high functional value on which he can travel thirty to thirty-five miles an hour. He follows this artery until he reaches an expressway on which he can proceed at forty-five to fifty miles or an intercity freeway at sixty-five to seventy miles an hour until he reaches a congested area diminishing his speed until he reaches his destination.

He cannot expect to maintain high speeds throughout his trip. He should expect reasonable travel-time commensurate with good highway planning and design, aided by proficient engineering control.

Face-lifting old highways may be difficult, but it should be done. Old roads and streets will *always* carry a high proportion of our traffic. Their improvement is as important as new highways.

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